PLAN CHANGE 14 TO THE WAIPĀ DISTRICT PLAN - MANGAONE PRECINCT

C10 Industrial Growth Cell, Hautapu

Stormwater Management Plan

Fonterra Limited

DOCUMENT CONTROL RECORD

CLIENT	Fonterra Limited
PROJECT	Plan Change 14 to the Waipā District Plan - Mangaone Precinct
HG PROJECT NO.	A2313738.00
HG DOCUMENT NO.	
DOCUMENT	Stormwater Management Plan

ISSUE AND REVISION RECORD

DATE OF ISSUE	12 April 2024
STATUS	Final

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1.0 INTRODUCTION

1.1 PURPOSE

The purpose of this Stormwater Management Plan (SMP) is to provide guidance to the applicant on stormwater management relating to development that will be enabled by proposed Plan Change 14 (PC14) to the Waipā District Plan within the Mangaone Precinct Structure Plan Area (hereafter referred to as the PC14 Structure Plan Area in this report), within the C10 Growth Cell at Hautapu.

We note that whilst PC14 seeks to rezone 79.2ha of land overall, this SMP report only addresses stormwater management within the PC14 Structure Plan Area, comprising 71.4ha of land owned by the applicant and identified in **Figure 1** below.

1.2 SCOPE

This SMP includes:

- A brief outline of the PC14 Structure Plan Area catchment, the Stormwater Management Guidelines for the Waikato Region (2020/05), and the On-site Stormwater Soakage Guidelines for Cambridge North Residential Zone (2014/05) provided by the Waipā District Council as the basis for the SMP;
- A stormwater management options assessment for the PC14 Structure Plan Area, which includes the best practicable option (BPO);
- The proposed stormwater management approach for the PC14 Structure Plan Area which includes stormwater quantity and quality management requirements for roads and industrial lots; and
- The present hydraulic modelling results and flood maps for the existing (pre-development) and future (post-development) scenarios.

The purpose of this SMP is to:

- Present relevant information regarding the current and proposed future management of stormwater within the PC14 Structure Plan Area;
- Demonstrate compliance with the Waipā District Plan, and the Waikato Regional Council's Stormwater Management Guidelines (SMG); and
- Identify a preferred stormwater management approach (BPO) to meet future stormwater management requirements.

1.3 STORMWATER MANAGEMENT GUIDELINES

This SMP is based on the principles and requirements of the following guidelines:

- Stormwater Management Guideline for the Waikato Region (2020/05) referenced in this report as the regional stormwater guideline.
- On-site Soakage Guidelines for Cambridge North Residential Zone (2014/05).
- Regional Infrastructure Technical Specifications (2018/05) – RITS.
- Waipā District Stormwater Bylaw 2019.
- New Zealand Building Code (NZBC) E1 – Surface Water.

2.0
SITE AND CATCHMENT CONTEXT

2.1 CATCHMENT CONTEXT

The Mangaone Precinct comprises 79.2 ha area of land bounded by the Zig Zag Road to the north, Swayne Road to the east, State Highway 1 to the south and the Bardowie Industrial Precinct and Bourke Farm to the west. The PC14 Structure Plan Area is within the catchment area of the Mangaone Stream and comprises 71.4ha of land outline in black in **Figure 1** below.

The Mangaone Stream is a watercourse running through the PC14 Structure Plan Area from east to west with a catchment of 482ha upstream of Swayne Road. The subcatchment containing most of the PC14 Structure Plan Area adds an additional 131.8ha until the stream crosses beneath Victoria Road approximately 650 metres to the west. The southwest corner of the PC14 Structure Plan Area is within another subcatchment that drains into the Mangaone Stream approximately 500 metres downstream from Victoria Road.

The Mangaone Stream divides the PC14 Structure Plan Area into two discrete catchments to the north and south of the stream. The southern catchment has a significantly larger area. Aside from the south-west corner, the southern catchment drains via an overland flowpath within the central part of the PC14 Structure Plan Area with a north-western flow direction. The northern catchment has a north-west flow direction and turns west until it unites with the Mangaone Stream approximately 500m to the west of the boundary, just upstream from Victoria Road.

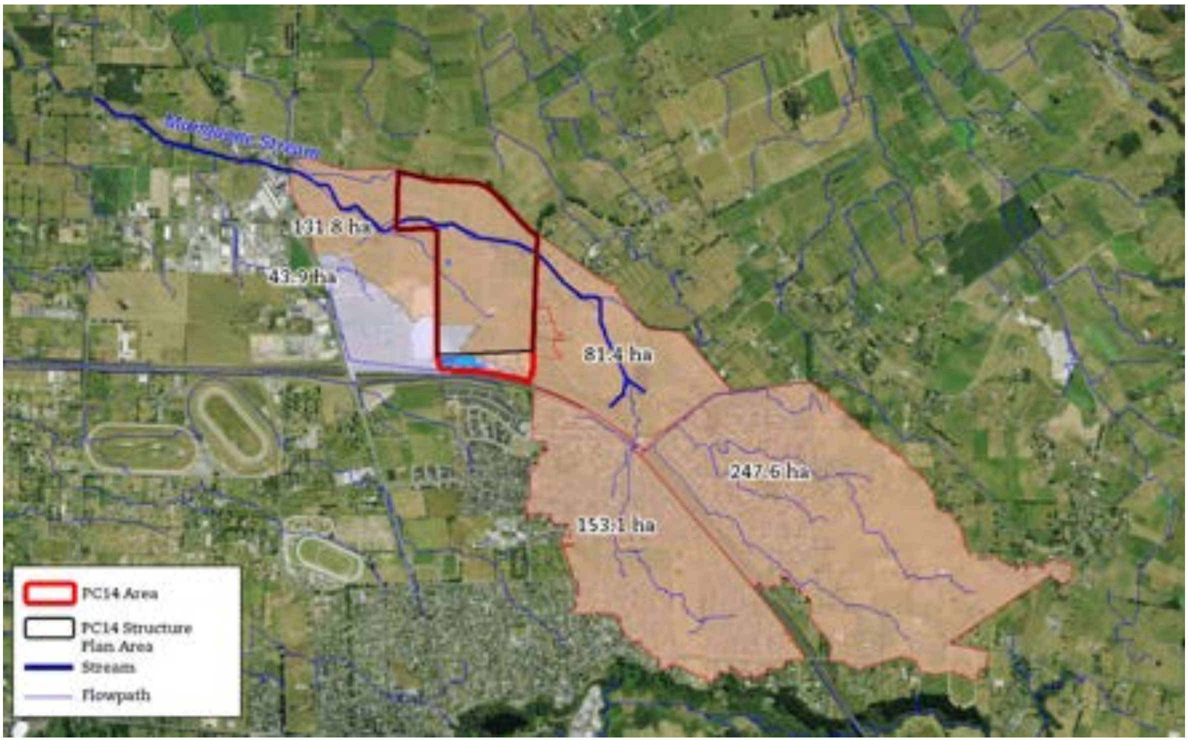

FIGURE 1: CATCHMENT AREA OF THE MANGAONE STREAM (THE MANGAONE PRECINCT (PC14 AREA) IS OUTLINED IN RED AND THE PC14 STRUCTURE PLAN AREA IS OUTLINED IN BLACK)

2.2 PC14 STRUCTURE PLAN AREA CONTEXT

2.2.1 EXISTING LAND ZONE

Under the Waipā District Plan, land within the Mangaone Precinct (referred to as the 'PC14 Area' in **Figure 2** and **Figure 3** below) is currently zoned 'Rural'. Latest aerial imagery (**Figure 3**) obtained from a 2023 drone survey of the PC14 Structure Plan Area shows that it greenfield and predominantly utilised as pasture with numerous accessways traversing the land. A historical dwelling and associated structures are located on the eastern boundary, while a wastewater facility and storage/laydown area lie in the northern central part. A substation facility is also located in the southern central part of the PC14 Structure Plan Area. The Mangaone Stream crosses the PC14 Structure Plan Area east to west with a number of natural and engineered wetlands present along its length.

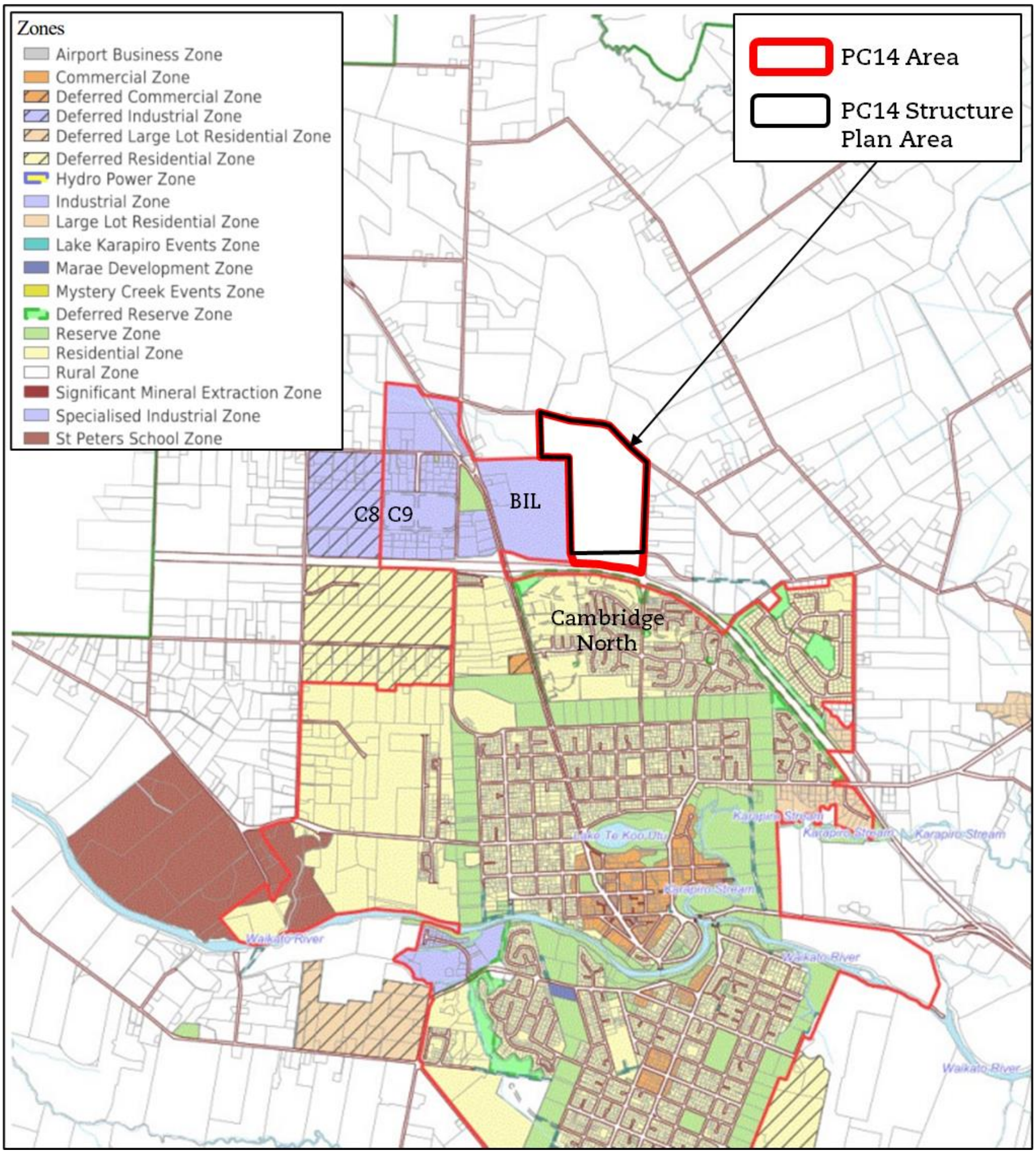

FIGURE 2: WAIPĀ DISTRICT PLAN (2017/08/17)

FIGURE 3: LATEST IMAGERY WITHIN THE PC14 STRUCTURE PLAN AREA (SURVEY, 2023/06) AND THE WIDER C10 GROWTH CELL (LINZ ORTOPHOTO 2021)

2.2.2 TOPOGRAPHY

Figure 4 shows the existing topography of the PC14 Structure Plan Area based on survey data (2023). The land is generally flat away from the Mangaone Stream corridor, having less than 5% slope across the land.

The PC14 Structure Plan Area is located at an elevation range of 58-75m reduced level (RL), with a relative elevation of approximately 2-3 metres above the Mangaone Stream and adjacent wetlands. Gentle slopes are observable along the wetland margins in both the northern and southern catchments.

While the ground naturally slopes towards the north-west, farm drains present within the PC14 Structure Plan Area have modified and redirected flows to drain towards the wetlands in a more perpendicular manner to the Mangaone Stream (**Figure 4**).

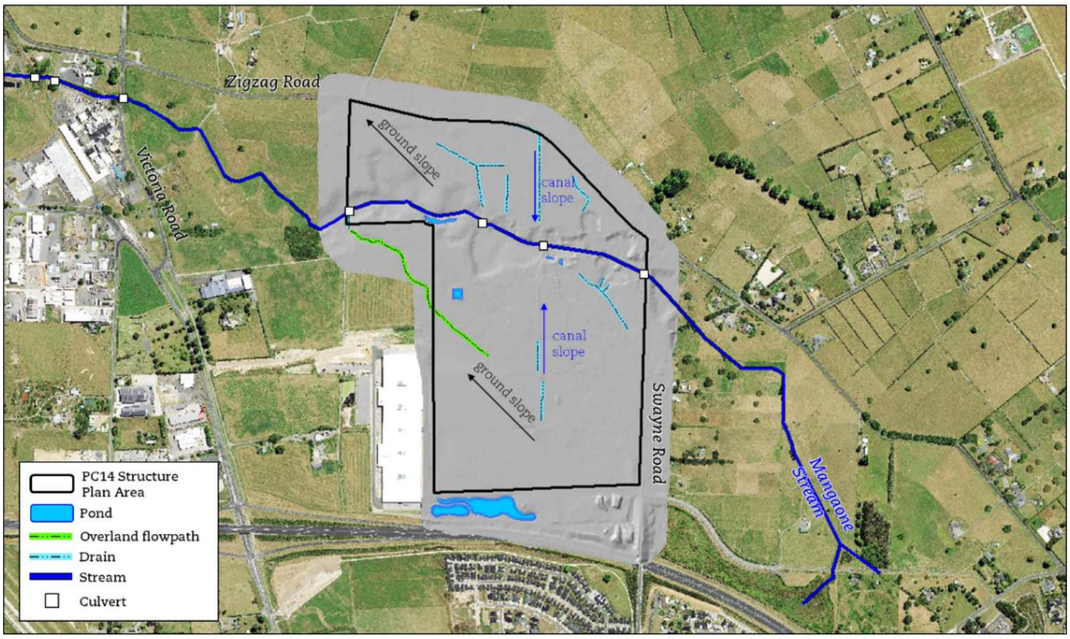

FIGURE 4: EXISTING LANDFORM

2.2.3 SURFACE WATER

The Mangaone Stream is the only natural surface water course going through the PC14 Structure Plan Area. The stream also serves as the receiving environment for runoff from the land. While old meanders of the stream form the wetland area existing today, the stream itself is narrow and can be described as modified/straightened taking the form of a rural drain. Straight sections continue downstream of the Hautapu Dairy Factory and beyond, and only starts to transition into a more incised natural gully about 1km west of Bruntwood village, where the stream is wider and deeper. The stream begins to meander until reaching the confluence with the Mangaonua Stream and eventually joins the Waikato River to the south of Hamilton City.

Topographic survey shows four culverts located within the PC14 Structure Plan Area along the course of the Mangaone Stream, as shown in **Figure 4**. Other culverts are also present outside of the PC14 Structure Plan Area, most notably those located downstream such as at Victoria Road and within the Dairy Factory to the west.

The Bardowie stormwater soakage pond is located immediately south of the PC14 Structure Plan Area boundary. Smaller ponds can be observed within the PC14 Structure Plan Area along the south bank of the Mangaone Stream and comprise natural and constructed wetlands.

2.2.4 GROUNDWATER

A key objective of the stormwater management solution for the PC14 Structure Plan Area is to utilise the existing soakage capabilities on the land in accordance with the Regional Infrastructure Technical Specifications (RITS) stormwater disposal hierarchy. Disposal to ground via soakage is intended to form an integral component of the stormwater management solutions where feasible, as it is the preferred option for reducing runoff to the Mangaone Stream as per Regional Stormwater Management Guideline and the RITS. In the PC14 Structure Plan Area, it is the seasonal groundwater level that presents potential limiting factor for the utilisation of stormwater soakage.

Winter groundwater level monitoring and spot checks (June 28 – July 24, 2023) by Soil and Rock Ltd and reported on by Beca indicate a varying groundwater elevation with a range of 60.5m-66.1m RL within the PC14 Structure Plan Area and a depth range of

0.2m-2.2m below existing ground level (**Figure 5**). Shallow flow is influenced by high groundwater levels and discharge to streamflow in a northerly direction. The shallowest groundwater is recorded beside the ancillary pump station near the centre of the PC14 Structure Plan Area and deepens to the north towards the stream and to the west and south (adjacent to the Bardowie Industrial Precinct). Shallow groundwater level is also observed along the swale area near the pump station draining to northwest. On the north bank of the Mangaone Stream, groundwater is on average approximately 1m below the existing ground level (Beca, 2023).

FIGURE 5: INFERRED GROUNDWATER LEVEL CONTOURS (BECA, 2023)

Shallow groundwater levels may limit the depth of future proposed stormwater ponds / constructed wetlands. Near the south bank of the Mangaone Stream, constructed wetlands may be designed to permanent water levels to coincide with groundwater levels of RL 61.5m-63.5m from west to east, depending on their locations. As groundwater levels are approximately 2 metres below ground level on these locations, and assuming a pond depth of 2 metres, the base of the constructed wetland will already be saturated by the groundwater, thus disposal of stormwater via soakage is not feasible on these locations.

The same condition can be observed for swales going through the PC14 Structure Plan Area. The bottom of swales with average depth of 1 metre will have minimal separation from the groundwater level. In this case, disposal via soakage along the swales is limited. Disposal via soakage to ground is also not possible along the north bank of the Mangaone Stream due to shallow groundwater levels.

Deeper groundwater can be found along the southwestern boundary of the PC14 Structure Plan Area. However, neighbouring stormwater ponds (Bardowie Industrial Precinct) located immediately south of the boundary already dispose of stormwater via soakage in this location. Additional stormwater ponds immediately neighbouring the existing ones can potentially increase the level of groundwater in this area, which can lead to lower soakage rates. Therefore, careful consideration should be given to providing sufficient separation from the existing Bardowie stormwater pond.

2.2.5 UNDERLYING SOILS

Geology maps (**Figure 6**) indicate that the PC14 Structure Plan Area is underlain by Hinuera Formation alluvial soil of the Piako Subgroup with recent alluvium present within the floodplain surrounding the stream. The Hinuera Formation soils are described as comprising fluvial pumiceous sand, gravel, and silt with occasional peat deposits.

FIGURE 6: GEOLOGICAL MAP (GNS NEW ZEALAND GEOLOGICAL WEB MAP 1:250K)

Infiltration rates of shallow soils beneath soakage basins will in part dictate the amount of stormwater that can be discharged into the ground. Infiltrometer measurements conducted by Soil and Rock Ltd via double-ring infiltrometer tests show high infiltration rates inside the “good ground condition” areas previously identified by Fonterra, and tests with low infiltration occur within “poor ground condition” areas (**Figure 7**).

Hydraulic conductivity determines how readily the disposed stormwater via soakage can be transported away from the PC14 Structure Plan Area. Tests conducted by Soil and Rock Ltd were not conclusive of the hydraulic conductivity of soils within the PC14 Structure Plan Area for saturated conditions.

While high infiltration rates are found in DR03 (**Figure 7**), this area has shallow groundwater levels, hence soakage to ground may not be possible. Meanwhile, high infiltration rates are also observed within the south-western portion of the PC14 Structure Plan Area coinciding with relatively deeper groundwater. Disposal of stormwater via soakage to ground may be more suitable in this area; however, the distance to the existing Bardowie stormwater pond still poses a risk of compounding effect leading to higher groundwater level. Furthermore, this area is located at the upstream edge of the PC14 Structure Plan Area which may not collect the majority of site runoff.

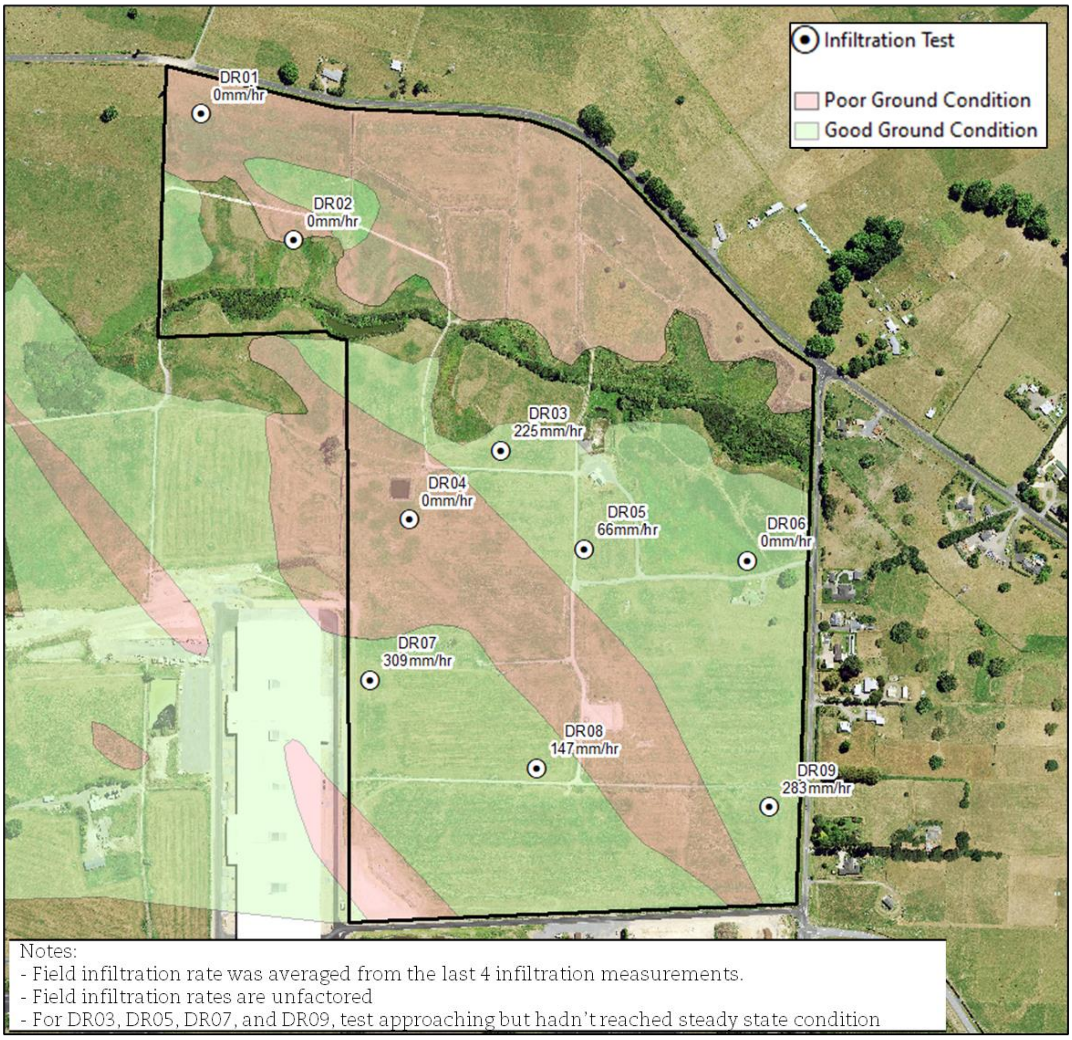

FIGURE 7: INFILTRATION TEST LOCATION

2.2.6 EXISTING STORMWATER NETWORK

As of November 2023, Waipā District Council's Online Maps do not show any public stormwater network infrastructure within the PC14 Structure Plan Area.

2.2.7 PROPOSED LAND ZONE

Land within the Mangaone Precinct is proposed to be rezoned to Industrial Zone, as illustrated by the red polygon in **Figure 8** (noting that the Mangaone Precinct is referred to as the 'PC14 Area' in this figure). This report covers the stormwater management plan of the PC14 Structure Plan Area only as represented by the black dashed line within the Mangaone Precinct.

Whilst it is proposed that the Industrial Zone be applied to the entire PC14 Structure Plan Area, the central portion of the PC14 Structure Plan Area, including land immediately to the north and south of the Mangaone Stream, has been identified as the most appropriate part of the PC14 Structure Plan Area to manage and treat stormwater runoff from future industrial development and activities. It is therefore highly likely that the Mangaone Stream corridor will vest with Council as a drainage/open space/recreation/cultural reserve and that proposed constructed wetlands will be accommodated within this corridor to manage and treat stormwater runoff from both the north and south catchment areas.

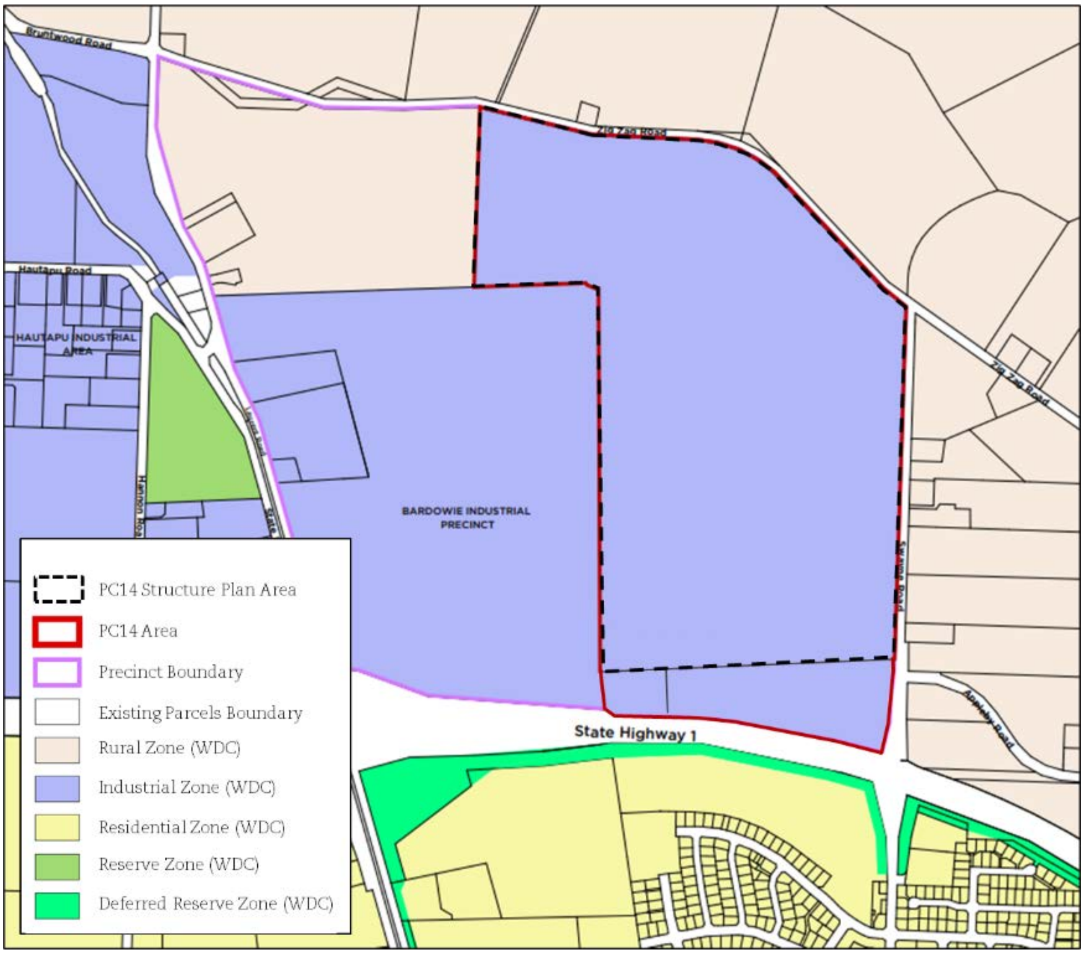

FIGURE 8: PROPOSED ZONING PLAN

Key proposed Structure Plan elements are shown in **Figure 9** over an aerial photograph base of the PC14 Structure Plan Area. **Figure 9** identifies the stormwater management area along the Mangaone Stream. It is noted that the locations of swales and constructed wetlands is indicative and is to be determined at resource consent stage.

Runoff from the PC14 Structure Plan Area will be conveyed via swales along the local roads towards future constructed wetlands to be located adjacent to the Mangaone Stream, integrated with the existing natural wetlands. At this stage, there are no definite locations or layouts of the constructed wetlands pending geotechnical investigations, but they are expected to be located within the proposed reserve adjacent to the stream and integrated with existing natural wetlands.

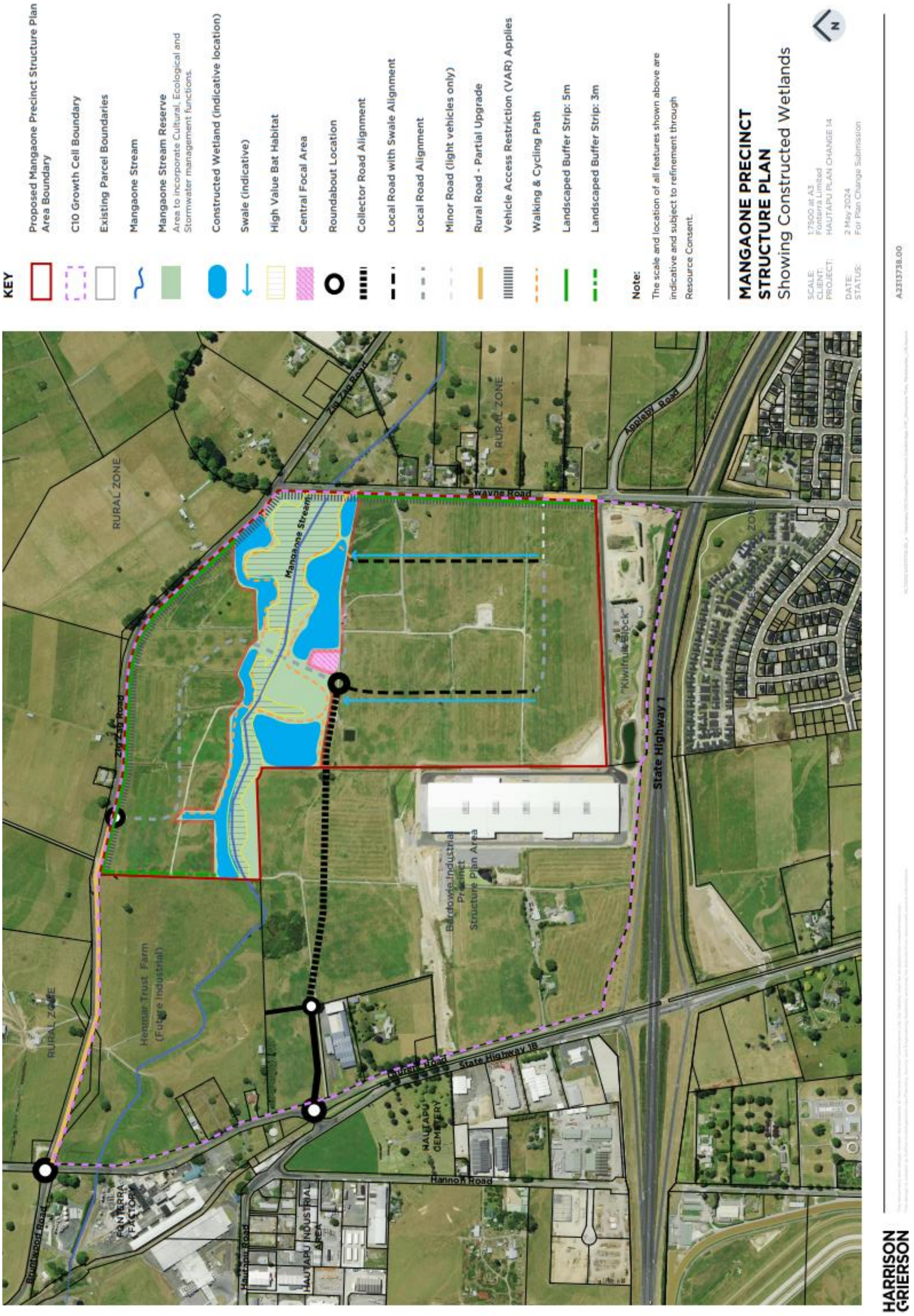

FIGURE 9: PROPOSED MANGAONE PRECINCT STRUCTURE PLAN (KEY ELEMENTS) OVERLYING AERIAL PHOTOGRAPH AND SHOWING INDICATIVE STORMWATER DEVICES

(Note: Number, location and shape of stormwater devices are indicative)

3.0 STORMWATER MANAGEMENT PLAN

3.1 BEST PRACTICABLE OPTIONS ASSESSMENT

Different options for stormwater management were analysed based on the existing PC14 Structure Plan Area conditions and context related to stormwater management. These options are summarised and discussed in **Table 1** below.

Table 1: Options Assessment

PROVISION	OPTIONS ASSESSMENT
Conveyance	• A piped system is not feasible as the primary stormwater network due to the very flat terrain within the PC14 Structure Plan Area resulting in small pipe slopes. Alternatively, larger pipe sizes and deeper minimum earth cover would result in high earthwork volumes and cost. • Swales are more appropriate in the PC14 Structure Plan Area to provide conveyance and pre-treatment to stormwater runoff prior to discharging to proposed constructed wetlands
Water Quality Treatment and Extended Detention	• Planting swales are assessed to provide water quality treatment to first flush storm events. However, the large catchment of the proposed industrial area requires a wide swale which is not economically feasible. The lengths of the swales also do not meet the minimum flow residence time to provide adequate water quality treatment. Hence, the swales are proposed to provide water quality pre-treatment to stormwater runoff instead of acting as the main treatment device. • Provision of on-lot water quality treatment is also assessed as an alternative. However, this additional condition is not economically attractive to future lot owners and is considered not feasible at this stage of the project. • Water quality treatment and extended detention are proposed to be provided using constructed wetlands. The regional stormwater guideline recommends utilising constructed wetlands due to its highwater quality treatment performance as a Low-Impact-Design (LID) device for stormwater.
Stormwater volume disposal	• The regional stormwater guideline recommends stormwater disposal to be via soakage to ground as a standard approach whenever feasible. However, shallow groundwater table and large uncertainty to the soil hydraulic conductivity within the PC14 Structure Plan Area makes this option not feasible. • As an alternative, the detention is proposed to be provided to the stormwater runoff volume from the development using live storage within the proposed constructed wetlands. The release of the detained volume shall be regulated by flow control structures such as appropriately designed orifice/culverts, to not exceed the pre-development flow rate from the PC14 Structure Plan Area.

3.2 STORMWATER PROVISIONS AND PERFORMANCE STANDARDS

The following provisions in **Table 2** shall be applied to the PC14 Structure Plan Area. The feasibility of achieving each provision has been tested and proven by dynamic surface flood modelling (1D/2D ICM).

Analysis of available data regarding groundwater and underlying soil conditions at this stage indicate that soakage ponds may not be feasible within the PC14 Structure Plan Area. Shallow groundwater and proximity to existing soakage ponds are the main constraints for soakage. Furthermore, the absence of conclusive hydraulic conductivity test results also contributes to the uncertainty of the effectiveness of soakage as a stormwater management option.

Based on these uncertainties, disposal of stormwater via soakage to ground is not considered in the stormwater management plan at this stage. We note however that future detailed investigation and assessment of hydrogeological characteristics within the PC14 Structure Plan Area may identify soakage as an option at detailed design stage.

Table 2: Stormwater Management Provisions for the Mangaone Precinct

STORM EVENT (ARI)	PROVISION	GUIDANCE	PROPOSED SOLUTION
All events	Contaminant management at source	Regional stormwater guideline, Waipā SW Bylaw	• Use of inert materials to be required to all new buildings to minimize discharge of concentrated dissolved contaminants. • Discharge to public stormwater network from high-risk facilities/sites as identified by the Schedule 1 of the Waipā District Stormwater Bylaw 2019 will require a separate discharge consent to be obtained, supported by a Pollution Prevention Plan as required by the Bylaw.
	First flush pre-treatment	Regional stormwater guideline, and RITS on-site water efficiency measures	• Appropriate water sensitive design applications such as proprietary devices to provide treatment at source to runoff from high use road activities and car parks prior to discharge to primary network. • Additional pre-treatment of all runoff going through the primary network shall be provided by proposed planted swales.
1/3 of 2yr	Water Quality Treatment	RITS and the Regional stormwater guideline	• Stormwater ponds / constructed wetlands shall provide water quality treatment.
1.2x Water Quality	Extended Detention	Regional stormwater guideline	• Stormwater ponds / constructed wetlands shall provide extended detention.
2yr	Balance of pre and post development peak runoff rate	Regional stormwater guideline	• Stormwater ponds shall attenuate 2yr post-development flow to pre-development level.

Table 3: Stormwater Management Provisions for the Mangaone Precinct

STORM EVENT (ARI)	PROVISION	GUIDANCE	PROPOSED SOLUTION
10yr	Primary drainage conveyance within the industrial area	RITS	• Swales along local roads to provide conveyance with level of service up to 10yr ARI.
	Balance of pre and post development peak runoff rate	Regional stormwater guideline	• Constructed wetlands shall attenuate 10yr ARI post-development flow to pre-development level.
	Soakage Disposal for the critical storm within communal basins to manage runoff from lots and road reserves	RITS, NZBC E1, Regional stormwater guideline	• Soakage disposal not considered at this stage due to shallow groundwater and limited information for soil hydraulic conductivity.
100yr	Secondary conveyance through the PC14 Structure Plan Area, with no people or property at risk	RITS and Regional stormwater guideline	• Flow in excess of 10yr to be conveyed via local road with level of service up to 100yr ARI.
	Attenuate peak flow and volume to the Mangaone Stream	RITS and Regional stormwater guideline	• Constructed wetlands shall attenuate 100yr post-development flow to appropriate pre-development level to eliminate additional flood risk to downstream properties.

3.3 LOW IMPACT DESIGN

The planning and design of stormwater management systems for the PC14 Structure Plan Area are in accordance with the regional stormwater guideline following Low Impact Design (LID). The proposed stormwater management approach for the PC14 Structure Plan Area will convey runoff via surface drainage channels and engineered overland flow paths (OLFPs) with attenuation in constructed wetlands. Water quality treatment provisions for public roads and private lots will be followed based on the requirements of the regional stormwater guideline.

3.4 STORMWATER MANAGEMENT AREAS

The northern and southern catchments within the PC14 Structure Plan Area comprise two discrete stormwater management areas, separated by the Mangaone Stream.

The subsequent sections of this SMP discuss the overarching integrated stormwater management solution for these catchment areas. Preliminary earthworks levels for future industrial subdivision and development of the PC14 Structure Plan Area indicate that the southern catchment can be further divided into two sub-catchments draining into two separate constructed wetlands, while the northern catchment can be divided into two or more sub-catchments draining into two or more separate constructed wetlands. The SMP and the stormwater model currently represent the northern and southern catchments as two separate catchments draining into the Mangaone Stream.

3.5 STORMWATER NETWORK

3.5.1 PRIMARY NETWORK

Roads and private lots are to be serviced by the primary stormwater network system with a level of service equivalent to the climate-adjusted 10% Annual Exceedance Probability (AEP) 24-hr design storm event. As a piped network is not feasible for the PC14 Structure Plan Area due to topographical limitations (the PC14 Structure Plan Area is too flat), swales along the roads are proposed to convey the primary flow requirement. All swales are to direct the flow towards the proposed constructed wetlands.

3.5.2 SECONDARY NETWORK

The road reserve along the swales shall convey the runoff from storm events exceeding 10% AEP and will have a level of service up to climate-adjusted 1% AEP 24-hr design storm event. Stormwater design will ensure that the flow depth and velocities along these roads shall not be unsafe to pedestrians and vehicles.

3.5.3 END-OF-NETWORK DEVICE

Constructed wetlands are proposed as end-of-network devices to provide water treatment and extended detention for first flush events. Furthermore, the constructed wetlands will have sufficient live storage to provide peak flow attenuation for storms up to 1% AEP event. The outlets shall be designed such that the combined flow from the constructed wetland and the Mangaone Stream will not increase the flood risk to the public and private assets downstream of the PC14 Structure Plan Area for 50%, 10%, and 1% AEP storm events.

3.5.4 MANAGING INFLOWS INTO AND THROUGH THE PC14 STRUCTURE PLAN AREA

The Mangaone Stream and adjacent natural wetlands will be maintained to preserve ecological values by applying a minimum riparian margin of 10-metre buffer from the wetlands and 20-metres from the stream. Future resource consents to modify the land within the stream/wetland corridor will need to be assessed under the National Policy Statement for Freshwater Management (NPS-FM) and the National Environmental Standards – Freshwater (NES-F), or any subsequent national policy documents, and to ensure that the flow behaviour and flood detention capability of existing wetlands is unaffected by proposed works. The pre-development flow from upstream via the Swayne Road culvert is not expected to change as a result of the future industrial subdivision and development of the PC14 Structure Plan Area.

3.6 WATER QUALITY TREATMENT

3.6.1 SOURCE MANAGEMENT

No at-source management of the first flush events is proposed for the PC14 Structure Plan Area as disposal via soakage to ground is limited by the varying groundwater depth across the land area. More detailed information of development layout and soil properties should be gathered at resource consent stage to refine stormwater management at source.

3.6.2 PRE-TREATMENT

Inlets from private lots to the public stormwater network shall be fitted with appropriate gross pollutant traps such as proprietary devices to remove macro contaminants from runoff prior to entering the public network.

Runoff from roads and private lots will also pass through the proposed planted swales which will provide pre-treatment to the first flush prior to entering the constructed wetlands.

3.6.3 END-OF-NETWORK DEVICE

As previously stated, constructed treatment wetlands are preferred as end-of-network devices to provide water quality treatment of flows from the stormwater network. The water quality volume is calculated from the 1/3 of the 2yr Average Recurrence Interval (ARI) storm event which is equivalent to the 90th percentile storm as per the RITS. 50% Water Quality Credit is applied based on the regional stormwater guideline. The calculated water quality treatment requirements are enumerated in **Table 4**. It is noted that the values in the table refer to the total water quality requirements and can be distributed to the number of constructed wetlands that will be provided based on their specific catchment area once refined at resource consent stage.

It should be noted that the area requirement in this table refers to the minimum wetland area for treatment only and does not include storage requirements for detention of stormwater up to 1% AEP. At this stage, there is uncertainty regarding the number and layout of the proposed constructed wetlands. However, to provide both treatment and detention up to 1%AEP, the constructed wetlands are expected to require an allocation of approximately 10-12% of the catchment area. The extent of the Mangaone Stream Reserve as shown on the PC14 Structure Plan (refer **Figure 9**) has been sized on this basis.

Table 4: Minimum Requirements for Constructed Wetlands to provide treatment

WETLAND DESIGN	CRITERIA	MINIMUM REQUIREMENTS	
		Northern Catchment	**Southern Catchment**
*Catchment Area (m^2) including constructed wetlands		155,785	431,150
Wetland Area (m^2)	3% of Catchment Area	4,674	12,935
Deep Marsh Area (m^2)	40% of Wetland Area	1,869	5,174
Shallow Marsh Area (m^2)	60% of Wetland Area	2,804	7,761
Water Quality Volume (WQV, m^3)	**IA x ($\%_{impervious}$ x $C_{impervious}$ + $\%_{pervious}$ x $C_{pervious}$)	2,835	7,847
Adjusted WQV (m^3)	50% of WQV if extended detention is applied	1,418	3,923
Extended Detention Volume (EDV, m^3)	1.2 of WQV	3,402	9,416
Forebay Volume (m^3)	15% of WQV	425	1,177

*Catchment area is assumed 75% impervious (runoff coefficient C=0.85) and 25% pervious (C=0.25). Refer to Table 6.
**I = 1/3 of 2yr rainfall depth = 26mm

3.7 EROSION PROTECTION

3.7.1 EROSION PROTECTION OF STORMWATER INFRASTRUCTURE

Appropriate planting media shall cover the stabilised swale bed and banks to minimise erosion. In addition, appropriate protection shall be provided along swale outer bends where necessary to protect the surface from higher flow velocities. Erosion protection shall also be implemented at the inlets and outlets of the swales, and in areas where concentrated flows may appear to minimise degradation of a swale and the receiving environment.

Erosion protection shall be implemented at the inlets, embankments, spillways, and outlets of the proposed wetlands to prevent degradation of the receiving watercourses. For inlets and outlets, riprap aprons with fenced headwalls will be provided. For embankments and spillways, deep-rooted planting and reinforced grass are proposed to provide cover to the stabilized walls.

The detailed design of erosion protection measures for swales and constructed wetlands shall be determined at resource consent stage.

3.7.2 EXTENDED DETENTION

The proposed constructed wetlands will discharge to the Mangaone Stream. To prevent erosion of the receiving environment, the constructed wetlands will provide extended detention (ED) in addition to water quality treatment. Following the Regional SMG, the ED volume will be 1.2 multiplied to the Water Quality Volume to be stored and released over a 24-hour period.

3.8 MANAGEMENT AND MAINTENANCE OF STORMWATER INFRASTRUCTURE

The recommended maintenance schedule for the different stormwater management infrastructure proposed in this SMP is outlined in **Table 5** below. The proposed stormwater management will comply with the Waipā District and Waikato Regional plan provisions. Once constructed, Waipā District Council will undertake the operation and maintenance of the stormwater infrastructure including the swales and the constructed wetlands.

Table 5: Operation And Maintenance Of Stormwater Infrastructure

ITEM	MAINTENANCE REQUIREMENT	FREQUENCY A = Annual M = Monthly BM = Bi-monthly AMS = After Major Storm S = After Monthly Storm	RESPONSIBLE ENTITY WDC = Waipā District Council
Primary Network			
Proprietary devices	Catchpits and gross-pollutant traps are to be inspected of accumulated debris and pollutants on a bi-monthly basis for correct operation and monitoring of sediment buildup. Floatable debris or litter to be removed during inspection. Cleanout of accumulated sediment shall be undertaken once sediment reaches 50% of the maximum storage volume. Details to be referred to supplier maintenance guide.	BM and depending on sediment volume	Private owners

Table 5: Operation And Maintenance Of Stormwater Infrastructure

ITEM	MAINTENANCE REQUIREMENT	FREQUENCY A = Annual M = Monthly BM = Bi-monthly AMS = After Major Storm S = After Monthly Storm	RESPONSIBLE ENTITY WDC = Waipā District Council
Swales	Engineered channels should be inspected at least on an annual basis, but also after any major storm event. Maintenance requirements to follow Regional SW Guideline – Appendix C.	A and AMS	WDC
Road OLFP	Engineered OLFPs should be inspected at least on annual basis, but also after any major storm event.	A and AMS	WDC
Outlets	OLFP outlets should be inspected at least on annual basis, but also after any major storm event where failures appeared to occur during the storm event.	A and AMS	WDC
Wetland	Maintenance requirements to follow Regional SW Guideline – Appendix C.	A, every 3 Months, and S	WDC

4.0 HYDRAULIC MODELLING

4.1 MODELLED SCENARIOS

Stormwater models of the PC14 Structure Plan Area were built using Infoworks ICM utilising a coupled 1D/2D model with the primary purpose of assessing the impact of future development of the PC14 Structure Plan Area on the flood behaviour of the Mangaone Stream. A comparison of the parameters used in the models between the pre- and post-development scenarios is provided in **Table 6**.

Table 6: Catchment Hydrology Modelling Parameters

PARAMETERS	PRE-DEVELOPMENT	POST-DEVELOPMENT
CATCHMENT SURFACE AND STORMWATER STRUCTURES		
Ground topography	Lidar data 2007-2008 updated with more recent surface in Cambridge area, St. Kilda development, Appleby swale, and Waikato Expressway. Topographic survey within the PC14 Structure Plan Area is found to be consistent with the Lidar data for flood simulation purposes.	
Catchment	Part of 2D mesh	PC14 Structure Plan Area is modelled as lumped sub-catchment discharging into constructed wetlands. The wetlands within the PC14 Structure Plan Area, and the areas outside, are represented as part of the 2D mesh.

Table 7: Catchment Hydrology Modelling Parameters

PARAMETERS	PRE-DEVELOPMENT	POST-DEVELOPMENT
Stormwater infrastructure	Existing culverts along Mangaone Stream are represented as 1D links. Culverts without available size and elevation information are burned as part of the DEM and captured by the 2D mesh.	Existing culverts along Mangaone Stream are represented the same way with the pre-development. Constructed wetlands within the PC14 Structure Plan Area are represented as 1D storage areas with controlled outfall to the existing wetland.
HYDROLOGY		
Rainfall depth	Source: High Intensity Rainfall Design Systems (HIRDS) Version 4. No climate change adjustment applied for pre-development. 1%AEP = 155 mm 10%AEP = 100mm 50%AEP = 65.8 mm	For areas outside of the PC14 Structure Plan Area represented as 2D mesh, the same pre-development rainfall is applied. For areas within the PC14 Structure Plan Area, adjustments were applied following the climate change temperature increase of 2.1 ˚C scenario, with adjusted rainfall as follows: 1%AEP = 181.0 mm 10%AEP = 113.2mm 50%AEP = 71.7 mm
Rainfall pattern (design storm)	From Waikato Stormwater Runoff Modelling Guideline (Waikato Regional Council Technical Report 2018/02)	
Rainfall losses	Effective rainfall is calculated externally to account for rainfall losses prior to being loaded into the 2D mesh.	For areas outside of the PC14 Structure Plan Area represented as 2D mesh, the same pre-development rainfall is applied. For areas within the PC14 Structure Plan Area represented as lumped sub-catchment, the rainfall is applied directly into the sub-catchment polygons. Rainfall losses are calculated internally by ICM based on Initial Abstraction and % impervious.
Impervious percentage within the site	0%	The following catchment distribution is assumed: **Industrial lots and roads** = 80% of site catchment at 90% impervious **Stormwater reserve** = 20% of site catchment at 15% impervious **Weighted average** = 75% impervious.
Mean composite CN within the site	66.5	90-92
Mean initial abstraction (Ia) within the site	1.40 mm	7.55 mm
	Based on composite CN according to the Waikato stormwater runoff modelling guideline (Waikato Regional Council Technical Report 2018/02).	
Surface roughness (manning n)	0.05	0.05

4.2 OUTLET CONTROL

For each constructed wetland, two separate outlets have been designed to provide the following:

- Outlet 1 is an orifice located exactly at the permanent water level in the constructed wetland and has been sized to discharge the minimum extended detention volume over a course of 24 hours.
- Outlet 2 is also an orifice located at the extended detention level in the pond to discharge the rest of the live storage to Mangaone stream. The orifice has been sized to ensure that post-development peak flows do not exceed pre-development peak flows from the respective catchment areas of the proposed constructed wetlands.

It should be noted that the outlet sizes are indicative at this stage, as well as the resulting peak outflows from the constructed wetlands. Opportunities to refine the outlet sizes and peak flows will be available once the numbers, locations, and layouts of the proposed constructed wetlands are finalised at resource consent stage.

4.3 MODEL RESULTS

4.3.1 PC14 STRUCTURE PLAN AREA RUNOFF

The peak flows of the northern and southern catchment are derived from the results of the pre-development scenario. The controlled outlets can reduce the post-development peak flows from the constructed wetlands to approximately 29-33% of the pre-development peak flows, as shown in **Figure 10**. It should be noted that previous iterations of the orifice sizes that achieved 80-100% of the pre-development peak flows increased the flood risk downstream of the PC14 Structure Plan Area, including the culverts in Victoria Road and those located in the Dairy Factory site. By further controlling the peak flows from the PC14 Structure Plan Area, the negative downstream impacts of the proposed development are fully mitigated and, in some areas, the flood levels are improved, as illustrated in **Figure 10** below.

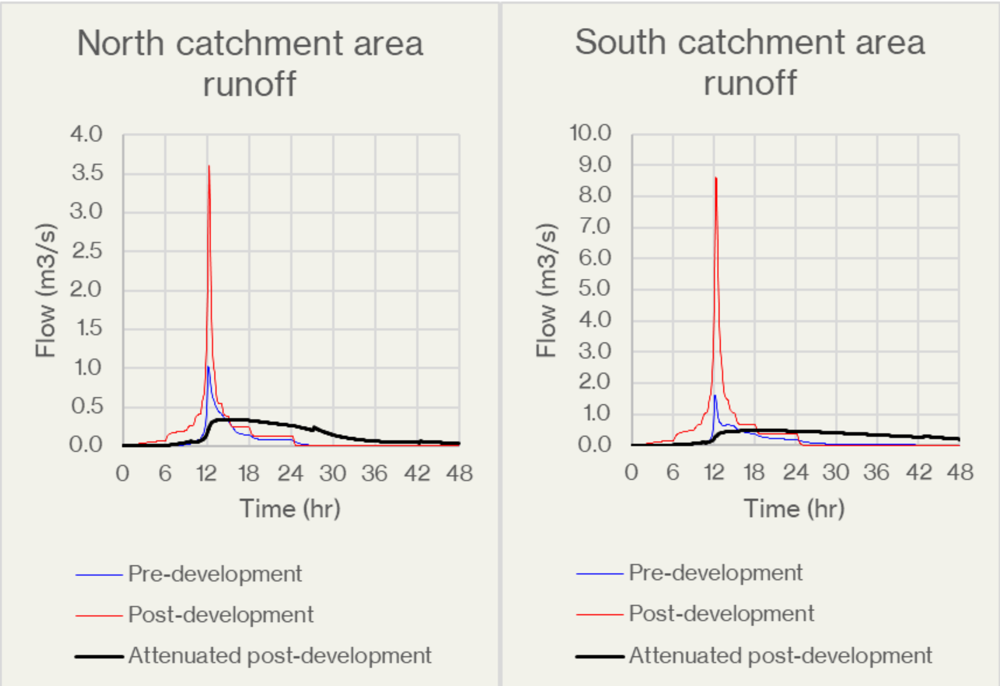

FIGURE 10: RUNOFF TIME SERIES FROM THE PC14 STRUCTURE PLAN AREA FOR 1% AEP STORM EVENT

4.3.2 DOWNSTREAM IMPACTS

Peak flows and flood levels were derived from the results of the hydraulic model in locations identified in **Figure 11**. A comparison of the peak flows and flood level between different storm event is summarised in **Table 8** and between pre- and post-development scenarios is summarised in **Table 7**. Positive values in the table mean higher discharge or flood levels in the post-development model compared to the pre-development; negative values mean lower discharge or flood levels in the post-development model compared to the pre-development. Zero values mean no observable change between the two scenarios.

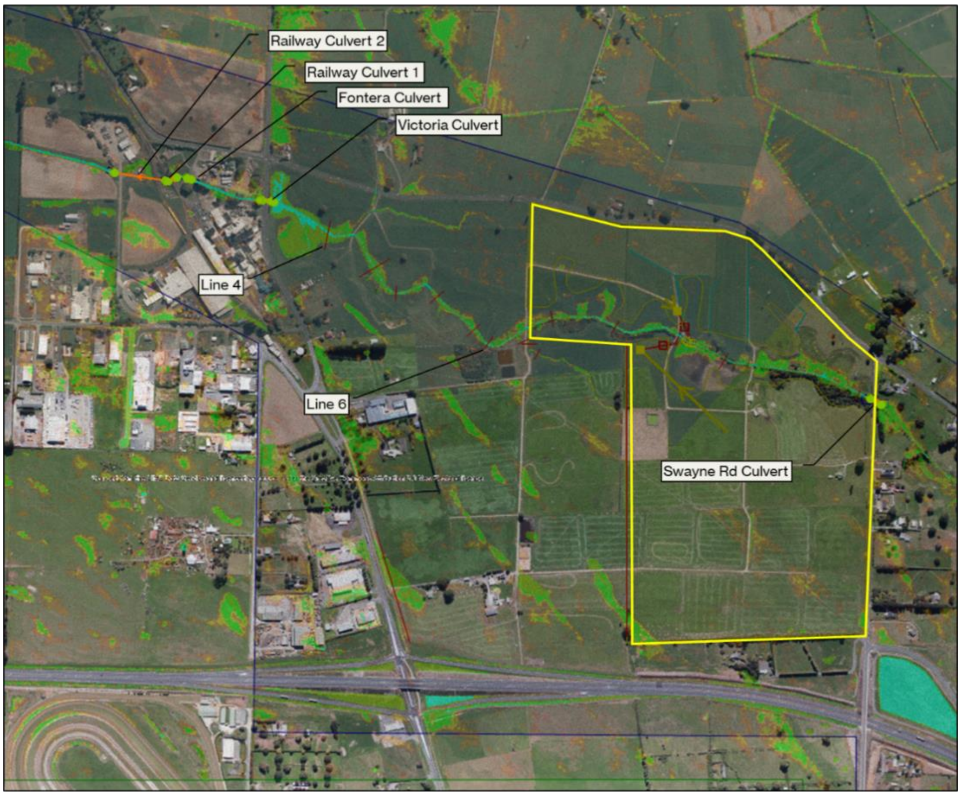

FIGURE 11: OBSERVATION POINTS WITHIN THE HYDRAULIC MODEL

Table 8: Summary of changes in peak flows and flood levels

LOCATION	50% AEP		10% AEP		1% AEP	
	Peak flow (m/s)	Flood level (m RL)	Peak flow (m/s)	Flood level (m RL)	Peak flow (m/s)	Flood level (m RL)
Swayne Rd Culvert	0.00	-0.01	0.00	0.00	0.00	-0.00
Line 6	-0.03	0.00	-0.22	0.00	0.00	0.00
Line 4	-0.10	0.00	-0.46	0.00	-0.59	0.00
*Victoria Road Culvert	-0.07	-0.03	-0.18	-0.09	0.08	0.02
*Fonterra Culvert	-0.07	-0.02	-0.19	-0.06	0.00	-0.01
*Railway Culvert 1	-0.07	-0.06	-0.20	-0.07	-0.01	-0.02
*Railway Culvert 2	-0.06	-0.26	-0.21	-0.16	-0.02	-0.03

*Flood levels are taken from the upstream end of the culverts except Swayne Rd

There is no observed significant change in the flood level and peak flow at the culvert along Swayne Road. This means that the proposed stormwater management solution for the PC14 Structure Plan Area will not change the water levels in the constructed wetland and will not cause backflow towards the upstream of the culvert.

Reduction of peak flow is observed for the two observation points (Lines 4 and 6), although the flood levels are maintained. This is related to the natural capability of the stream to partially detain water along the stream/wetland corridor.

Small increases in both discharge and flood level are observed to the culvert beneath Victoria Road, but this is limited to the extreme storm event only (1% AEP). Further investigation of the hydraulic model results show that the timing of the peak flow and flood level has changed in the post-development scenario (**Figure 12**) because of the flow attenuation applied to the PC14 Structure Plan Area. However, while the change in timing is also observable further downstream, the increase in peak flow and flood level is localised and does not propagate further downstream. Moreover, the increased flood level is very small (within the range 2cm-2.5cm) and flood extent which will be confined to the existing flood plain area.

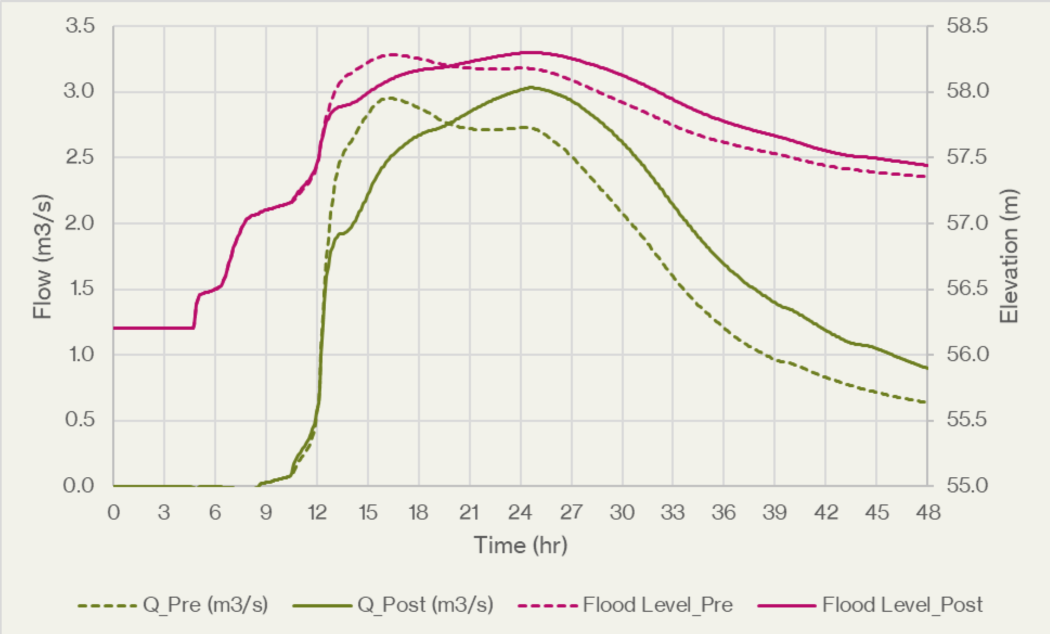

FIGURE 12: FLOW AND FLOOD LEVEL TIME SERIES IN VICTORIA CULVERT (1% AEP)

Aside from the culvert along Victoria Road, all other culverts further downstream are observed to experience a decrease in flood levels. In these locations, the decrease in flood levels is more pronounced in the more frequent storm events (10% and 50% AEP).

As previously discussed, red values indicate a small increase in flood depth at the upstream end of Victoria Road culvert and does not propagate to the downstream floodplain. The slight increase in flood depth is also mitigated by the lower flood level further downstream near the culverts along the railway.

Table 9: Peak flows and flood levels

LOCATION	PRE-DEVELOPMENT		POST-DEVELOPMENT	
	Peak flow (m/s)	**Flood level (m RL)**	**Peak flow (m/s)**	**Flood level (m RL)**
50%AEP				
Swayne Rd Culvert	0.08	61.85	0.09	61.84
Line 6	0.36	60.77	0.34	60.77
Line 4	0.47	59.71	0.37	59.71
*Victoria Culvert	0.45	57.42	0.38	57.39
*Fonterra Culvert	1.12	57.18	1.05	57.15
*Railway1 Culvert	1.12	56.30	1.05	56.24
*Railway 2 Culvert	1.12	56.04	1.06	55.77
10% AEP				
Swayne Rd Culvert	0.48	62.06	0.48	62.06
Line 6	1.21	60.77	0.99	60.77
Line 4	1.59	59.71	1.13	59.71
*Victoria Culvert	1.28	57.67	1.10	57.58
*Fonterra Culvert	2.00	57.31	1.80	57.25
*Railway1 Culvert	2.01	56.50	1.81	56.43
*Railway 2 Culvert	2.02	56.20	1.82	56.04
1% AEP				
Swayne Rd Culvert	2.10	62.51	2.10	62.51
Line 6	2.93	60.77	2.93	60.77
Line 4	3.65	59.71	3.06	59.71
*Victoria Culvert	2.96	58.28	3.03	58.30
*Fonterra Culvert	3.71	57.60	3.70	57.60
*Railway1 Culvert	3.72	57.08	3.71	57.05
*Railway 2 Culvert	3.73	56.71	3.72	56.68

Note: Green figures indicate reduced value, red figures indicate increased value

The results of the 2D flood models have been extracted to generate the flood maps in **Appendix 1**. From these flood depths, the flood level differences for each storm event have been post-processed in GIS. For 1% AEP storm event in **Figure 13**, localized increase in flood level can be observed along the stream/wetland corridor within the PC14 Structure Plan Area boundary. The mitigation of this effect along the stream/wetland corridor immediately downstream of the PC14 Structure Plan Area is associated with the utilisation of the stream/wetland corridor's natural retention capacity. Further refinement of the number of constructed wetlands and the location of the outfalls during the resource consent stage can optimise the utilisation of the wetland within the PC14 Structure Plan Area. More outfalls distributed in different locations along the stream/wetland corridor will change the peak flow timing for each pond/wetland and potentially reduce the negative impact on flood depth.

The impact upstream of Victoria Road culvert has also been investigated and found to be consistently within 2cm-2.5 cm range of increased flood levels and does not affect the downstream areas. The rest of the flooded areas do not change from the pre-development flood condition.

For the 10% and 50% AEP storm events in **Figure 14** and **Figure 15**, localised impact can be observed along the stream/wetland corridor within the PC14 Structure Plan Area which is also mitigated immediately downstream. For these more frequent storm events, flood levels are observed to be reduced by 2cm-6cm along Victoria Road culvert and into the downstream Dairy Factory site. This positive impact is associated mainly with the large attenuation proposed to be provided within the PC14 Structure Plan Area.

FIGURE 13: FLOOD LEVEL DIFFERENCE FOR 1% AEP STORM EVENTS

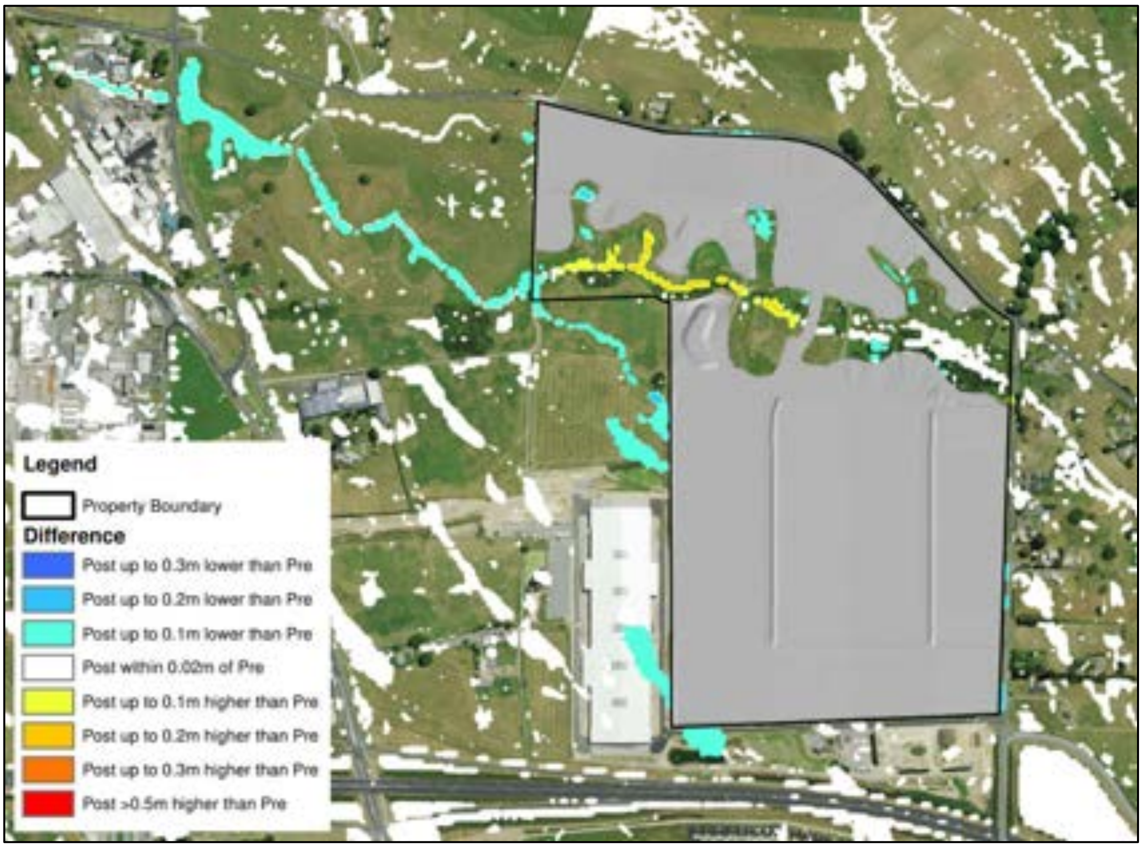

FIGURE 14: FLOOD LEVEL DIFFERENCE FOR 10% AEP STORM EVENTS

FIGURE 15: FLOOD LEVEL DIFFERENCE FOR 50% AEP STORM EVENTS

5.0 CONCLUSION AND RECOMMENDATIONS

The recommended stormwater management solution for the PC14 Structure Plan Area as discussed in this SMP report can be summarised as follows:

- The proposed PC14 Structure Plan Area is to be serviced by the primary stormwater network system with a level of service equivalent to the 10% AEP 24hr design storm event. Due to the topographical limitations of the PC14 Structure Plan Area, the primary network is proposed to be composed of planted swales along the road reserve.
- The secondary stormwater system along road reserves shall be designed to service runoff from the PC14 Structure Plan Area up to 1% AEP 24hr design storm event.
- Both primary and secondary networks shall convey runoff towards the proposed constructed wetlands.
- Water quality pre-treatment shall be provided via treatment train approach by the following:
    - At-source controls such use of inert building (roofing) materials shall be implemented via conditions of consent and/or consent notices to those developing and/or owning new buildings within the PC14 Structure Plan Area.

  - Appropriate water sensitive design applications such as proprietary devices shall be installed to provide pre-treatment of runoff from high-risk facilities as classified in the Waikato Regional Plan, prior to discharge to stormwater network.
  - Planted swales shall also provide pre-treatment of runoff from public roads where applicable.

- The first-flush runoff will be provided with water quality treatment and extended detention via proposed constructed wetlands to be accommodated adjacent to the Mangaone Stream within the existing stream/wetland corridor. The number and layout of constructed wetlands is indicative and will be subject to refinement at resource consent stage. The design of the constructed wetlands shall follow the requirements of the regional stormwater guidelines.

- Due to the shallow groundwater levels prevalent across the majority of the PC14 Structure Plan Area, and the limited hydraulic conductivity of underlying soil, disposal of stormwater via soakage is unlikely to be feasible for both the swales and the constructed wetlands. Therefore, the peak flow rate in the post-development scenario is proposed to be reduced via attenuation within the constructed wetlands.

- The stormwater management solution for the PC14 Structure Plan Area assumes that the full runoff volume up to 1% AEP will be attenuated within the constructed wetlands. Refinement of swale sizing to distribute the required detention volume to optimise the swale land take shall be undertaken at resource consent stage.

- The outlets of the constructed wetlands shall be designed to control the peak flows and to minimise any increase in flood risk downstream of the PC14 Structure Plan Area. The post-development hydraulic model indicates that this can be achieved by reducing the peak flow to approximately 50% of the pre-development peak flow of the 1% AEP storm event. By doing so, the flood risks downstream are also not increased for 10% and 50% AEP storm events.

- Erosion protection for the proposed stormwater infrastructure shall be provided as follows:

  - Appropriate planting media and stabilised walls are to be provided to the swales and constructed wetland embankments and spillways.
  - Constructed wetland inlets and outlets shall be provided with protection where applicable
  - Swales shall be provided with appropriate cover (riprap) along bends to protect channel banks.

- Flood models illustrate that for the 50% and 10% AEP storm events, the impact on the flood levels along the existing Mangaone Stream/natural wetland corridor is localised within the PC14 Structure Plan Area boundary and is fully mitigated by lower flood levels downstream. For the 1% AEP storm event, there is a 2cm-2.5 cm increase in flood level just upstream of Victoria Road, but there is no additional flood effect to the west of the Victoria Road culvert. Potential downstream flood effects are also mitigated by lower flood levels further downstream near the culverts along the railway.

6.0 LIMITATIONS

6.1 GENERAL

This report is for the use by Fonterra Limited only and should not be used or relied upon by any other person or entity or for any other project.

This report has been prepared for the particular project described to us and its extent is limited to the scope of work agreed between the client and Harrison Grierson Consultants Limited. No responsibility is accepted by Harrison Grierson Consultants Limited or its directors, servants, agents, staff or employees for the accuracy of information provided by third parties and/or the use of any part of this report in any other context or for any other purposes.

APPENDIX 1
FLOOD MAPS

HARRISON GRIERSON

Legend

- Property Boundary
- Catchment 10

1% AEP Flood Elevation Difference

- Post up to 0.3m lower than Pre
- Post up to 0.2m lower than Pre
- Post up to 0.1m lower than Pre
- Post within 0.02m of Pre
- Post up to 0.1m higher than Pre
- Post up to 0.2m higher than Pre
- Post up to 0.3m higher than Pre
- Post >0.5m higher than Pre

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N

Scale: 1:6,595 (A3 Size)

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Hautapu - PC14 Growth Cell 10 Plan Change

1% AEP Storm Event Flood Elevation Difference

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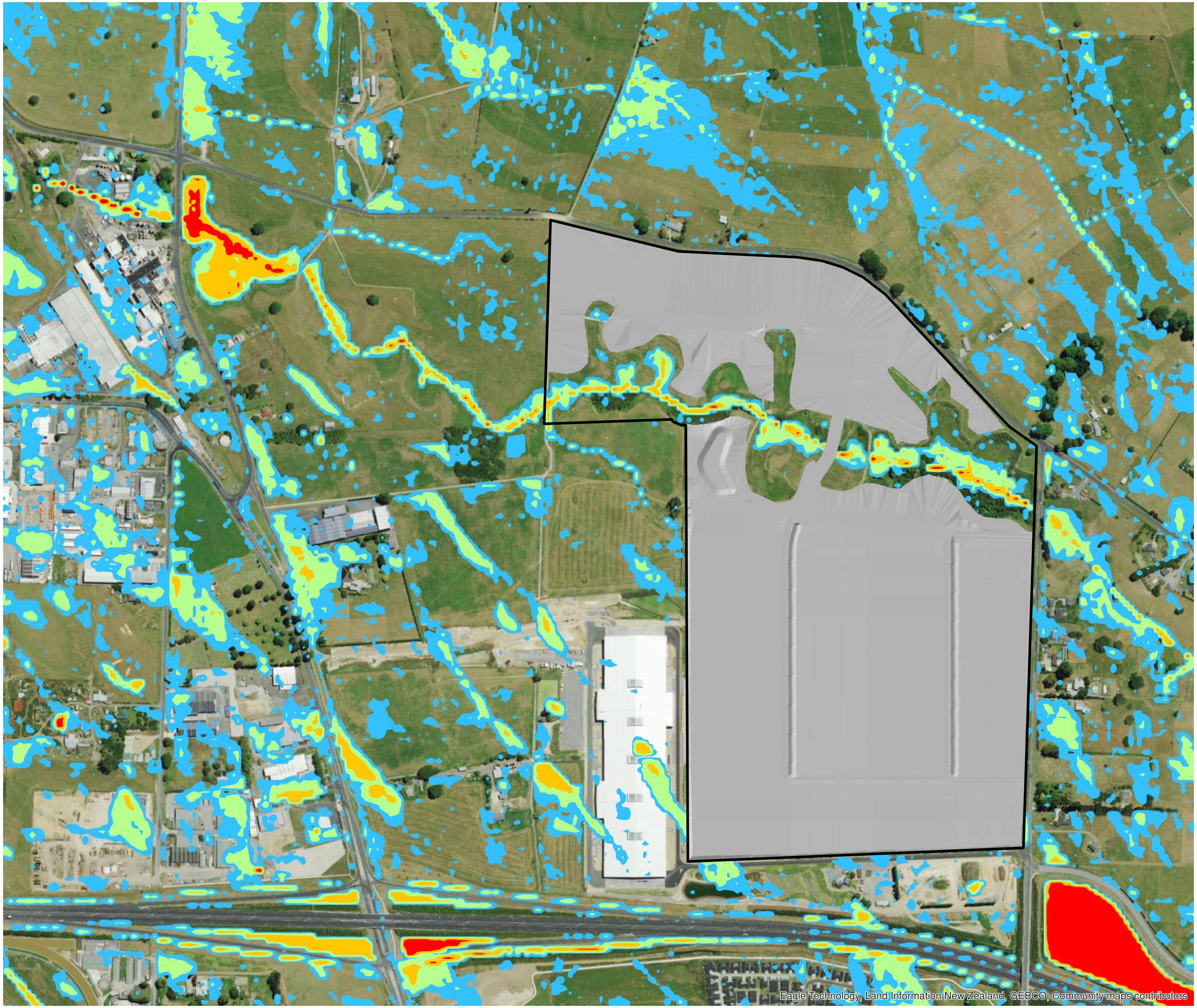

HARRISON GRIERSON

Legend

- Property Boundary
- Catchment 10

1% AEP Post development Flood Depth

- < 0.05m
- 0.05m - 0.2m
- 0.2m - 0.5m
- 0.5m - 1m
- >1m

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Hautapu - PC14
Growth Cell 10
Plan Change

1% AEP Storm Event
Post Development Flood Depth

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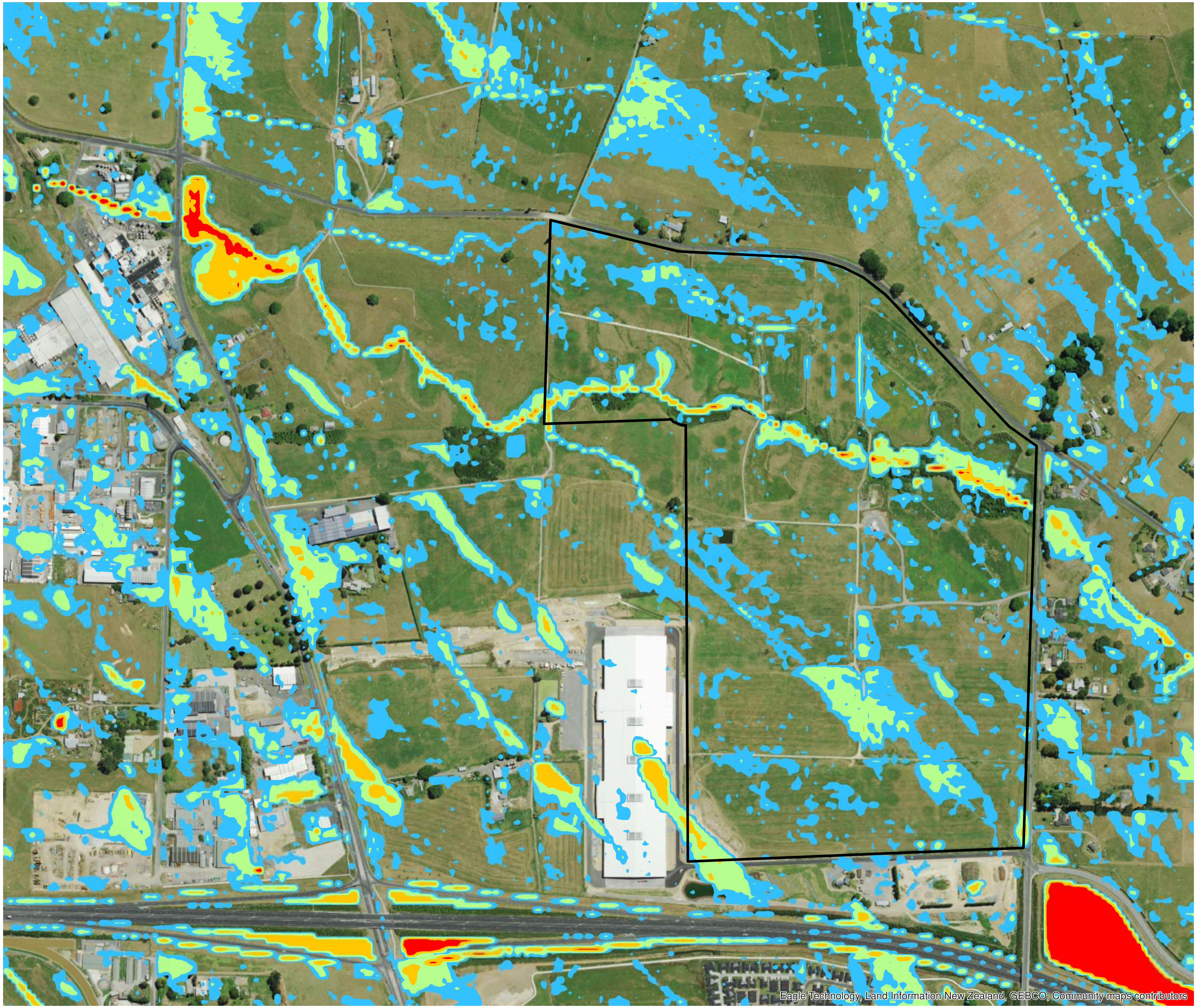

HARRISON GRIERSON

Legend

- Property Boundary
- < 0.05m
- 0.05m - 0.2m
- 0.2m - 0.5m
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- >1m

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Hautapu - PC14 Growth Cell 10 Plan Change

1% AEP Storm Event Predevelopment Flood Depth

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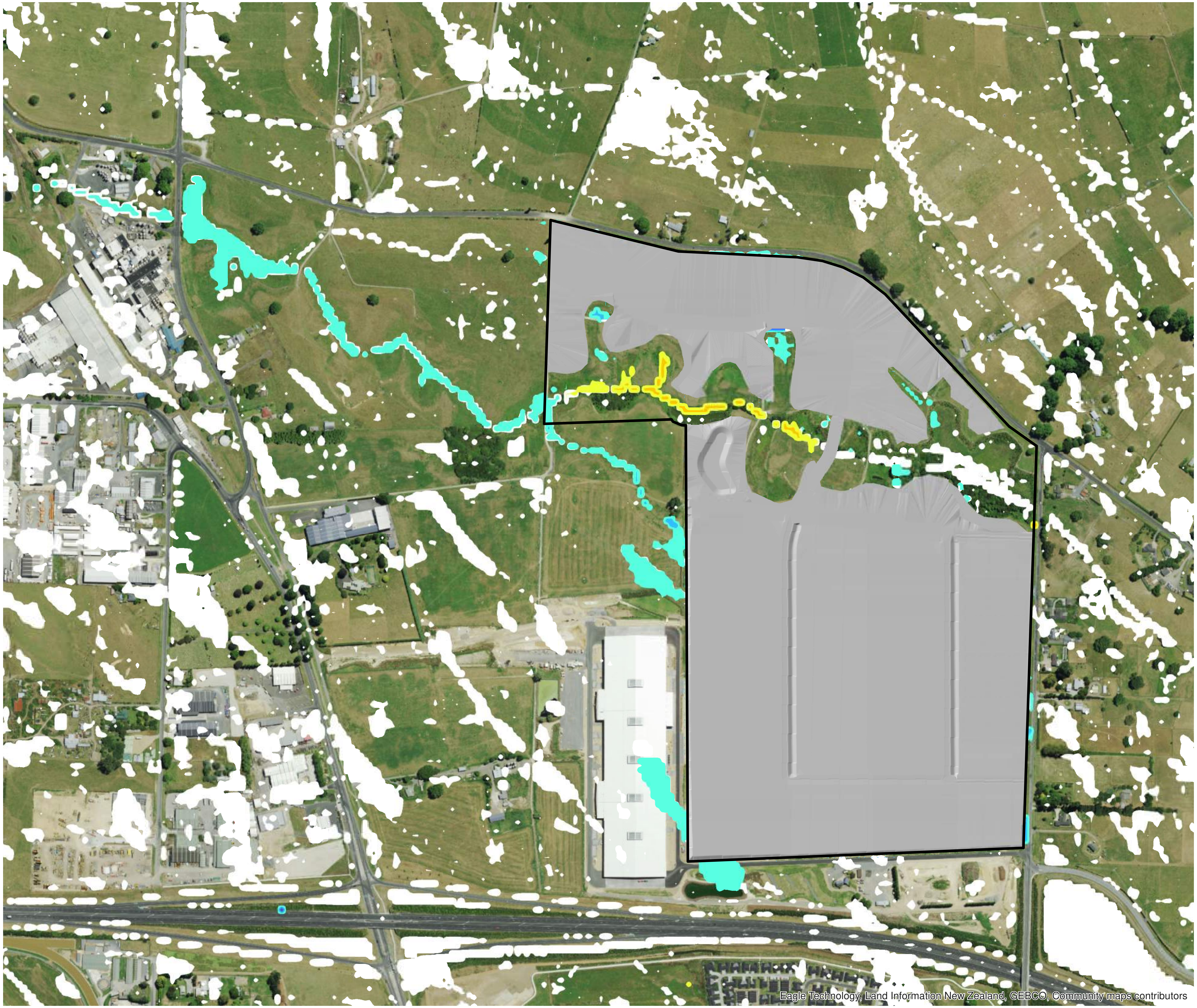

HARRISON GRIERSON

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- Catchment 10

10% AEP Flood Elevation Difference

- Post up to 0.3m lower than Pre
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- Post up to 0.1m lower than Pre
- Post within 0.02m of Pre
- Post up to 0.1m higher than Pre
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Hautapu - PC14
Growth Cell 10
Plan Change

10% AEP Storm Event
Flood Elevation Difference

MAP NO:

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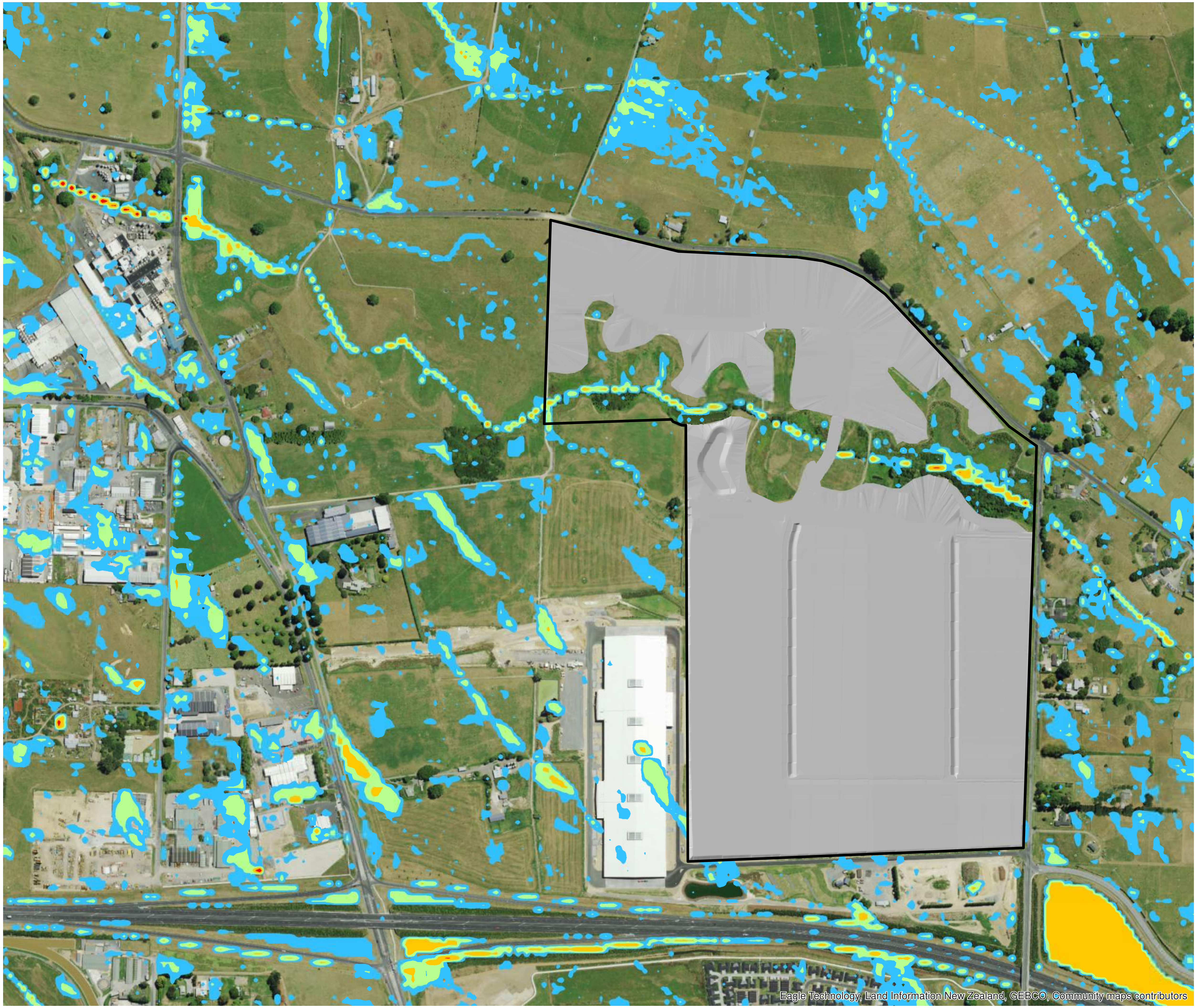

HARRISON GRIERSON

Legend

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- Catchment 10

10% AEP Post development Flood Depth

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Hautapu - PC14
Growth Cell 10
Plan Change

10% AEP Storm Event
Post Development Flood Depth

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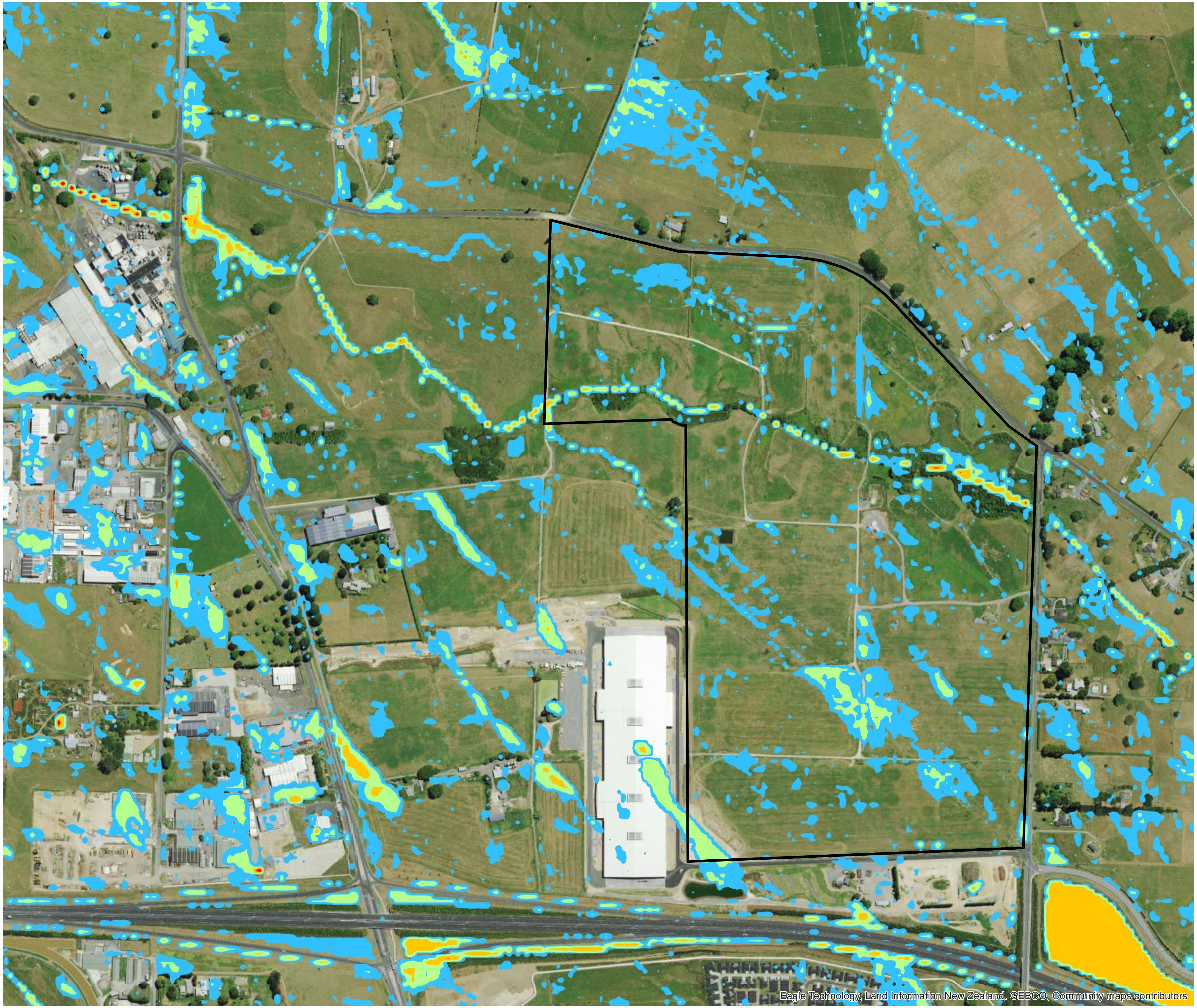

HARRISON GRIERSON

Legend

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Hautapu - PC14
Growth Cell 10
Plan Change

10% AEP Storm Event
Predevelopment Flood Depth

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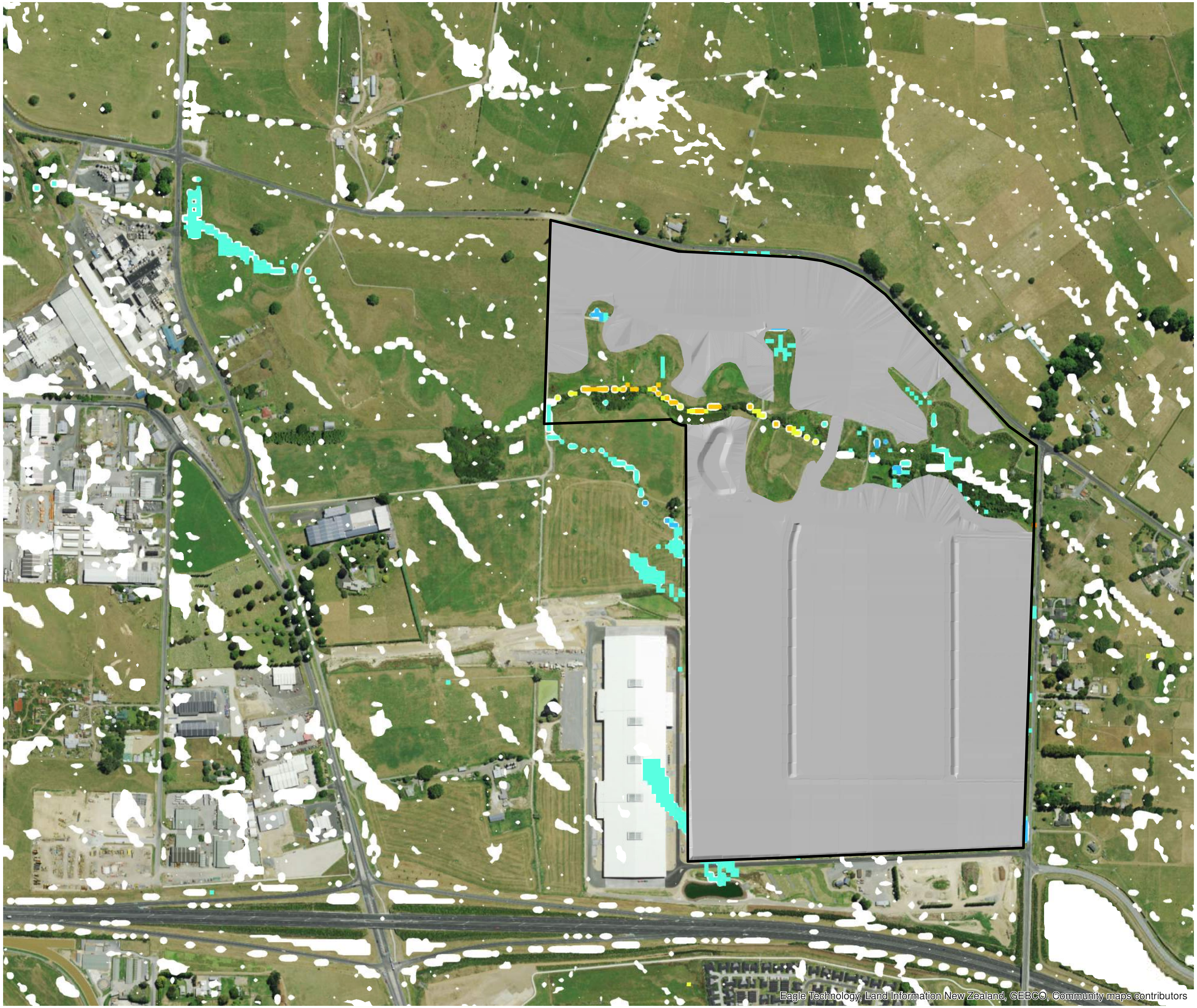

HARRISON GRIERSON

Legend

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- Catchment 10

50% AEP Flood Elevation Difference

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Hautapu - PC14
Growth Cell 10
Plan Change

50% AEP Storm Event
Flood Elevation Difference

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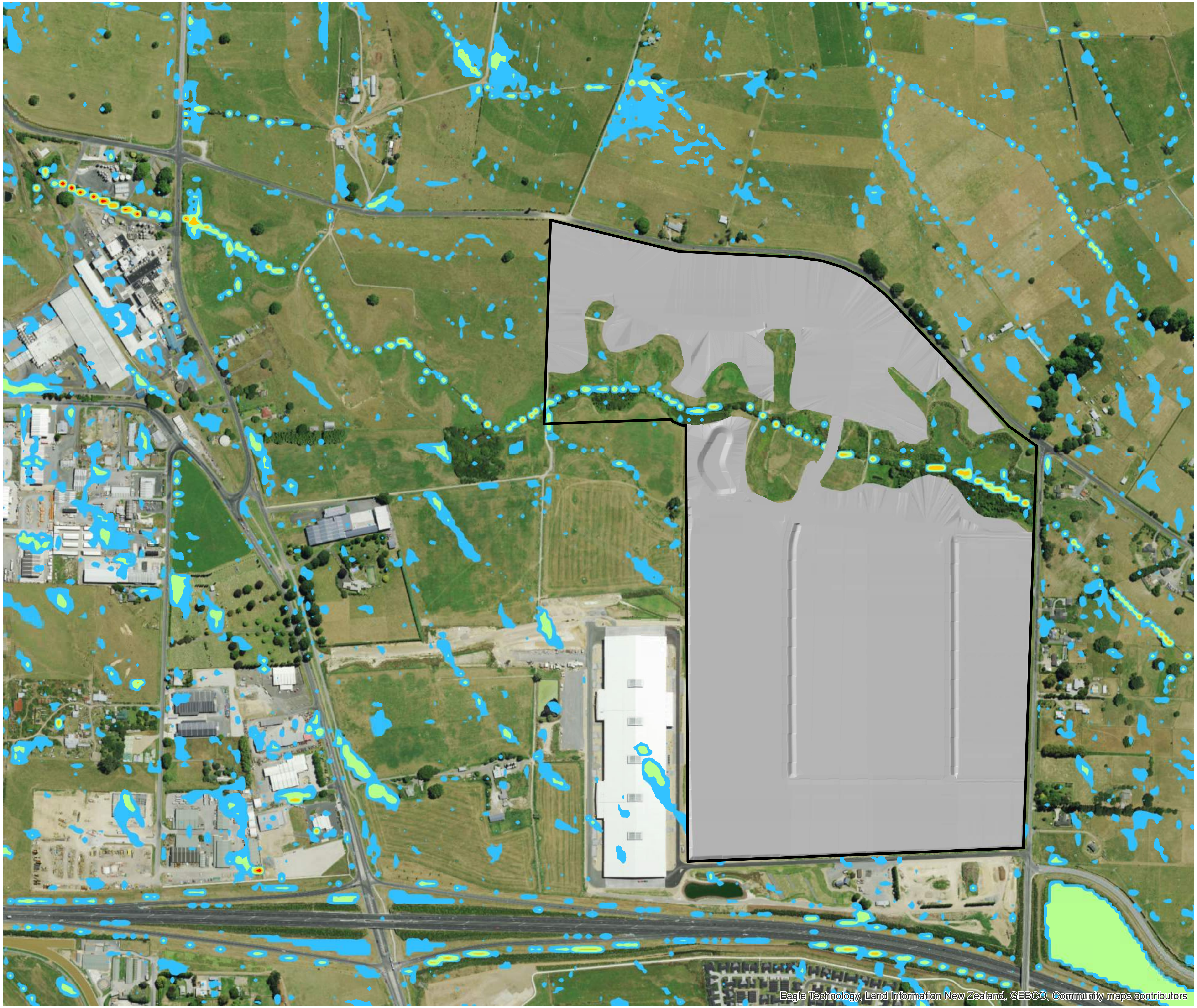

HARRISON GRIERSON

Legend

- Property Boundary
- Catchment 10

50% AEP Post development Flood Depth

- < 0.05m
- 0.05m - 0.2m
- 0.2m - 0.5m
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Scale: 1:6,595 (A3 Size)

0 0.0325 0.065 0.13 0.195 Kilometers

Hautapu - PC14
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Plan Change

50% AEP Storm Event
Post Development Flood Depth

MAP NO:

A2313738.00.01

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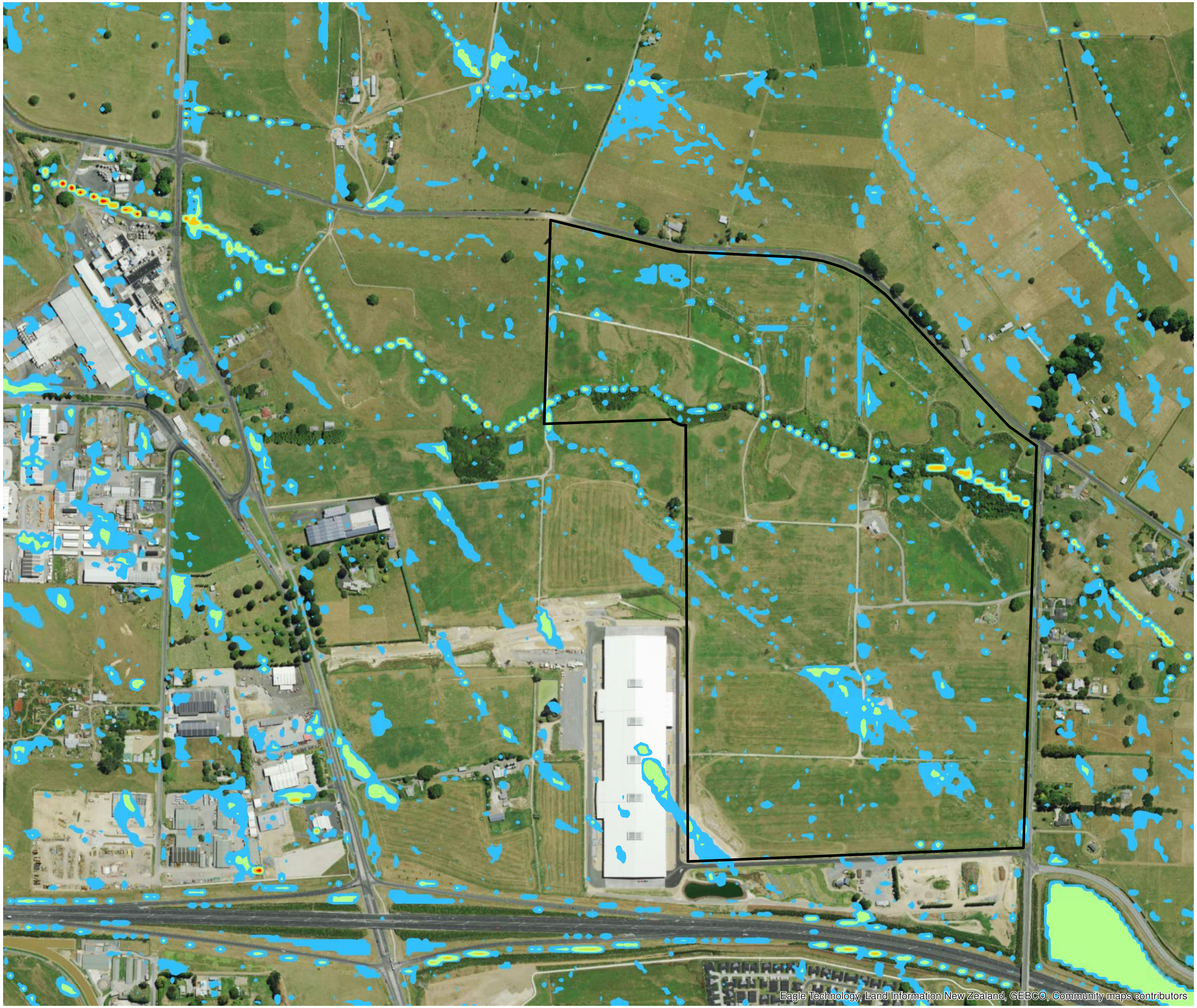
Last saved by: TIF 2023-12-11 Last Plotted: 2023-12-11



HARRISON GRIERSON

Legend

Property Boundary

50% AEP Pre development Flood Depth

- < 0.05m
- 0.05m - 0.2m
- 0.2m - 0.5m
- 0.5m - 1m
- >1m

ASSOCIATION OF CONSULTING ENGINEERS NEW ZEALAND

ISO 9001 QUALITY ASSURED

REV	ISSUE STATUS	DATE
Rev1	FINAL	11.12.23

DESIGNED:	CHR	DATE:	11/12/2023
DRAWN:	TIF	DATE:	11/12/2023
CHECKED:	CHR	DATE:	11/12/2023
APPROVED:	CHR	DATE:	11/12/2023

N

Scale: 1:6,595 (A3 Size)

0 0.0325 0.065 0.13 0.195 Kilometers

Hautapu - PC14
Growth Cell 10
Plan Change

50% AEP Storm Event
Predevelopment Flood Depth

MAP NO:

A2313738.00.01

File Path:\\hgc-gis-01\GIS\WR_PROJECTS_SHARE_FOLDER\49_Hautapu_PC14_C10\03_GIS\07TIF Raster Processing\HG_Hautapu_105.mxd

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Document Set ID: 11223908
Version: 1, Version Date: 13/05/2024

APPENDIX 2
CONSTRUCTED WETLAND CALCULATIONS

Hautapu PC14 - Growth Cell 10

Designed Chito Rosario
Reviewed Dipal Harrat
Date 18/12/2023

Preliminary Wetland Design - North Catchment Area

Per Waikato Stormwater Management Guideline 2020

	Public Roads	Lots	Total	Notes
Wetland Catchment				
Catchment Area (m^2)	-	155,785	155,785	Lots+Roads+Swales+Pond assumed 75% Impervious
(ha)	-	*15.5785*	*15.5785*	
Impervious Coverage (%)	60%	75%		
Wetland Pool Area Estimate (m^2)	-	4,674	4,674	3% of catchment area (Waikato SMG)
(ha)	-	*0.4674*	*0.4674*	
Adjusted Wetland Pool Area Estimate (m^2)	-	8,880	8,880	Adjusted by a factor of 1.9 to attenuate 100yr volume
(ha)	-	-	-	
Runoff Coefficients				
C (impervious)	0.80	0.85		Runoff coefficients as per NZ Building Code E1 Surface Water.
C (pervious)	0.25	0.25		
Design Rainfall				
Rainfall I (mm)	26.00	26.00		1/3 of 2yr rainfall, max 30mm (Waikato SMG)
Water Quality Area (A_{wq})				
Water Quality Catchment Area (m^2)	-	109,050	109,050	
(ha)	-	*10.9050*	*10.9050*	
Water Quality Volume (V_{wq})				
Water Quality Volume (m^3)	-	2,835	2,835	
Water Quality Volume with 50% Credit (m^3)	-	1,418	1,418	
Extended Detention Volume (V_{ed})				
Extended Detention Volume (m^3)	-	3,402	3,402	
Wetland Design Volume				
Total Volume (m^3)	-	4,820	4,820	
Peak Flow Estimates (Q_{wq})				
Q (impervious) (m^3/s)	-	0.72	0.72	90% storm adopted from the 1-in-2-year ARI, 1-hour duration event.
Q (pervious) (m^3/s)	-	0.07	0.07	
Wetland Bathymetry Design				
Forebay Volume as % of WQV			30%	Minimum 15% of WQV, 30% if ED is required
Forebay Design Volume (m^3)			851	
Deep Pool Areas @ 0.5 - 1.0 m depth (m^2)			3,552	min 40% of estimated wetland area = 1869 sq.m
Shallow Pool Areas @ 0.0 - 0.5 m depth (m^2)			5,328	min 60% of estimated wetland area = 2804 sq.m
Estimated Average Forebay Depth (m)			1.00	Internal embankment side slopes are factored into depth estimate.
Forebay Surface Area (m^2)			851	
Total Surface Area at WQV (m^2)			**9,730**	
Surface Area at WQV as a % of Catchment			**6.25%**	
Design Water Levels				
Forebay Invert Level (m)			60.00	
Forebay Weir Level / Permanent Water Level (m			61.50	
Forebay Depth (m)			1.50	Minimum 1.5m (Waikato SMG)
Deep Pool Invert Level (m)			60.80	
Deep Pool Depth (m)			0.70	
Shallow Pool Invert Level (m)			61.30	
Shallow Pool Depth (m)			0.20	
Extended Detention Peak Level (m)			61.85	EDV > 100%. Ok.
Extended Detention Depth (m)			0.35	
Dead Storage - Forebay				
Forebay Volume (m^3)			851	
Internal Side Slopes 1V: H			4.0	
Base Area (m^2)			295	Assumes forebay is a square shape.
Average Forebay Depth (m)			1.01	
Dead Storage- Deep Pools				
Number of Deep Pools			3	Assumes pools are square.
Deep Pools Base Area (m^2)			2,490	
Deep Pools Volume (m^3)			2,115	
Dead Storage- Shallow Pools				
Number of Shallow Pools			2	Assumes pools are square.
Shallow Pools Base Area (m^2)			5,003	
Shallow Pools Volume (m^3)			1,033	

Total Water Quality Volume Provided (m^3)		3,998	
Target Water Quality Volume (m^3)		1,418	
% of Water Quality Volume Provided		282.0%	WQV > 100%. Ok.
Live Storage Volumes			
Internal Side Slopes 1V: H		**4.0**	
Extended Detention Top Area (m^2)		10,419	Assume wetland is L:W=3:1
Total Extended Detention Volume Provided (m^3)		3,525	
Target Extended Detention Volume (m^3)		3,402	
% of Extended Detention Volume Provided		104%	EDV > 100%. Ok.
Total Surface Area at EDV (m^2)		**10,419**	
Surface Area at EDV as a % of Catchment		**6.69%**	
ED Outlet Orifice Sizing			
$Q_{ed,design}$ (m^3/s)		0.04	
Max release rate $Q_{ed,max}$ (m^3/s)		0.08	Assumes 2x Q_{ed}.
Orifice diameter (mm)		**275**	Largest standard outlet size with Q<Qed
ED Orifice Area (m^2)		0.06	
Dimension h		0.21	
Q_{ed} (m^3/s)		0.08	OK
Q100 Outlet Orifice Sizing			
Max release rate $Q_{100,max}$ (m^3/s)		**0.49**	55% of Q100 less Qed
Orifice diameter (mm)		**450**	
Orifice Area (m^2)		0.16	
Design Water Level		**62.80**	
Dimension h		0.72	
Q_{100} (m^3/s)		0.37	Q100<Q100,max. OK.
Emergency Spillway Sizing			
Peak Flow Rate (m^3/s)		**3.70**	Assume = Q100 inflow
Spillway Freeboard above Design Water Level (n		**0.10**	
Spillway Invert Level (m)		62.90	
Depth of Flow over Spillway (m)		**0.20**	
Spillway Design Flow Level (m)		63.10	
Spillway Width L (m)		24.10	
Wetland Crest			
Wetland Crest Freeboard above Spill Flow (m)		**0.30**	RITS
Wetland Crest Level (m)		63.40	
Total Surface Area at Crest (m^2)		**13,750**	
Surface Area at Crest as % of Catchment		**8.83%**	

Hautapu PC14 - Growth Cell 10

Preliminary Wetland Design - South Catchment Area

Per Waikato Stormwater Management Guideline 2020

Designed Chito Rosario
Reviewed Danny Curtis
Date 25/10/2023

	Public Roads	Lots	Total	Notes
Wetland Catchment				
Catchment Area (m^2)	-	431,150	431,150	Lots+Roads+Swales+Pond assumed 75% Impervious
(ha)	-	*43.1150*	*43.1150*	
Impervious Coverage (%)	60%	75%		
Wetland Pool Area Estimate (m^2)	-	12,935	12,935	3% of catchment area (Waikato SMG)
(ha)	-	*1.2935*	*1.2935*	
Adjusted Wetland Pool Area Estimate (m^2)	-	25,222	25,222	Adjusted by a factor of 1.95 to attenuate 100yr volume
(ha)	-	-	-	
Runoff Coefficients				
C (impervious)	0.80	0.85		Runoff coefficients as per NZ Building Code E1 Surface Water.
C (pervious)	0.25	0.25		
Design Rainfall				
Rainfall I (mm)	26.00	26.00		1/3 of 2yr rainfall, max 30mm (Waikato SMG)
Water Quality Area (A_{wq})				
Water Quality Catchment Area (m^2)	-	301,805	301,805	
(ha)	-	*30.1805*	*30.1805*	
Water Quality Volume (V_{wq})				
Water Quality Volume (m^3)	-	7,847	7,847	
Water Quality Volume with 50% Credit (m^3)	-	3,923	3,923	
Extended Detention Volume (V_{ed})				
Extended Detention Volume (m^3)	-	9,416	9,416	
Wetland Design Volume				
Total Volume (m^3)	-	13,340	13,340	
Peak Flow Estimates (Q_{wq})				
Q (impervious) (m^3/s)	-	1.99	1.99	90% storm adopted from the 1-in-2-year ARI, 1-hour duration event.
Q (pervious) (m^3/s)	-	0.19	0.19	
Wetland Bathymetry Design				
Forebay Volume as % of WQV			30%	Minimum 15% of WQV, 30% if ED is required
Forebay Design Volume (m^3)			2,354	
Deep Pool Areas @ 0.5 - 1.0 m depth (m^2)			10,089	min 40% of estimated wetland area = 5174 sq.m
Shallow Pool Areas @ 0.0 - 0.5 m depth (m^2)			15,133	min 60% of estimated wetland area = 7761 sq.m
Estimated Average Forebay Depth (m)			1.15	Internal embankment side slopes are factored into depth estimate.
Forebay Surface Area (m^2)			2,047	
Total Surface Area at WQV (m^2)			**27,269**	
Surface Area at WQV as a % of Catchment			**6.32%**	
Design Water Levels				
Forebay Invert Level (m)			60.00	
Forebay Weir Level / Permanent Water Level (m			61.50	
Forebay Depth (m)			1.50	Minimum 1.5m (Waikato SMG)
Deep Pool Invert Level (m)			60.80	
Deep Pool Depth (m)			0.70	
Shallow Pool Invert Level (m)			61.30	
Shallow Pool Depth (m)			0.20	
Extended Detention Peak Level (m)			61.85	EDV > 100%. Ok.
Extended Detention Depth (m)			0.35	
Dead Storage - Forebay				
Forebay Volume (m^3)			2,354	
Internal Side Slopes 1V: H			4.0	
Base Area (m^2)			1,105	Assumes forebay is a square shape.
Average Forebay Depth (m)			1.15	
Dead Storage- Deep Pools				
Number of Deep Pools			3	Assumes pools are square.
Deep Pools Base Area (m^2)			8,234	
Deep Pools Volume (m^3)			6,413	
Dead Storage- Shallow Pools				
Number of Shallow Pools			2	Assumes pools are square.
Shallow Pools Base Area (m^2)			14,582	
Shallow Pools Volume (m^3)			2,972	

Total Water Quality Volume Provided (m^3)		11,739	
Target Water Quality Volume (m^3)		3,923	
% of Water Quality Volume Provided		299.2%	WQV > 100%. Ok.
Live Storage Volumes			
Internal Side Slopes 1V: H		**4.0**	
Extended Detention Top Area (m^2)		28,414	Assume wetland is L:W=3:1
Total Extended Detention Volume Provided (m^3)		9,744	
Target Extended Detention Volume (m^3)		9,416	
% of Extended Detention Volume Provided		103%	EDV > 100%. Ok.
Total Surface Area at EDV (m^2)		**28,414**	
Surface Area at EDV as a % of Catchment		**6.59%**	
ED Outlet Orifice Sizing			
$Q_{ed,design}$ (m^3/s)		0.11	
Max release rate $Q_{ed,max}$ (m^3/s)		0.22	Assumes 2x Q_{ed}.
Orifice diameter (mm)		**350**	Largest standard outlet size with Q<Qed
ED Orifice Area (m^2)		0.10	
Dimension h		0.18	
Q_{ed} (m^3/s)		0.11	OK
Q100 Outlet Orifice Sizing			
Max release rate $Q_{100,max}$ (m^3/s)		**0.50**	55% of Q100 less Qed
Orifice diameter (mm)		**400**	
Orifice Area (m^2)		0.13	
Design Water Level		**62.80**	
Dimension h		0.75	
Q_{100} (m^3/s)		0.30	Q100<Q100,max. OK.
Emergency Spillway Sizing			
Peak Flow Rate (m^3/s)		**8.75**	Assume = Q100 inflow
Spillway Freeboard above Design Water Level (n		**0.10**	
Spillway Invert Level (m)		62.90	
Depth of Flow over Spillway (m)		**0.20**	
Spillway Design Flow Level (m)		63.10	
Spillway Width L (m)		57.64	
Wetland Crest			
Wetland Crest Freeboard above Spill Flow (m)		**0.30**	RITS
Wetland Crest Level (m)		63.40	
Total Surface Area at Crest (m^2)		**33,764**	
Surface Area at Crest as % of Catchment		**7.83%**	